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ORGANISATION OF SCIENTIFIC AND INDUSTRIAL RESEARCH

THE report entitled "Science, the Endless Frontier" made by Dr. Vannevar Bush to the President of the United States last year (see *Nature*, August 4, 1945) proposed much increased concern with the organisation of scientific and industrial research on the part of the Federal Government of the United States, and indicated that the United States was contemplating steps taken in Britain some thirty years ago. In some features, however, particularly in regard to recruitment and training for industrial or technical research, the report showed that the United States is more alive to the opportunities and possibilities than is Great Britain. While in regard to academic research the United States may have something to learn from British institutions, in regard to technology the reverse is true ; and the programme and ideas set forth in the Bush Report should be carefully studied by those responsible for technical education in Britain and for implementing the recommendations of the Percy Report.

One of the most interesting features that emerged from a first reading of the Bush Report was the extent to which opinion in both countries appears to be moving on parallel lines with regard to the organisation of research. That is further demonstrated by the recent article by Ward Shepherd in *Science* of January 18. Under the title "Science for Democracy", he makes a more or less frontal attack on the programme outlined by Dr. Bush as failing to meet the ideal of a broadly conceived national science programme. Some of his criticisms of the Bush Report may strike an independent observer as tinged with political prejudice, for that report enunciates clearly enough the fundamental principles—generous and assured financial support, rigorously safeguarded freedom of inquiry, and a place for science at the centre of our civilization—which Mr. Shepherd regards as the basis for building a science of civilization. For all that, much of Mr. Shepherd's criticism expresses what a British reader might have thought without caring to utter.

The main point of Mr. Shepherd's criticism is the exclusion of the social sciences, and the political rather than scientific preoccupation of the Bush programme. He regards it as inspired by a negative rather than the positive conception of government, which in Britain has come to govern our whole thinking about the machinery of government. He considers that the organisation suggested in the report will be satisfactory neither from the point of view of Government nor of the men of science, and that what might emerge is a powerful scientific oligarchy which could in practice control science and scientific men without any effective check either from the Government or the great body of scientific workers.

The ultimate question concerning the use of the social sciences is whether we should apply organised intelligence, so far as possible, to understanding and directing change, or whether we should leave change

to the struggle of passion and faction. The full use of all science, including social science, is indispensable for intelligent progress in all the great tangle of human problems that confront modern government. In any national science programme worthy of the name, the social sciences must be at the core of scientific effort, and especially at the core of Government, which is their laboratory and testing ground.

Mr. Shepherd quotes the recent statement of the Committee for a National Science Foundation as disposing of the two main fears engendered by the Bush Report—fear of Government and apprehension for social inquiry: "The freedom of inquiry upon which science is dependent can be guaranteed under government no less than under private auspices. The Government should support research in all fields of fundamental scientific inquiry relevant to national interest without arbitrary exclusion of any area". Science, Mr. Shepherd holds, can be democratically organised far more effectively and with greater real freedom than under an isolationist, *laissez-faire* regime, and the National Science Foundation visualized by the Shapley-Urey Committee will require the active democratic co-operation of State, regional and national scientific bodies in formulating scientific programmes and allocating scientific funds. Scientific men themselves must have a voice and a responsible part in determining priorities, the complete and adequate covering of the whole scientific field, the co-ordination of effort and the whole-hearted democratic application of the results of research. Beyond this is needed a body of responsible public servants, with adequate means, both financial and co-operative, to assist the organised men of science in making the most of the national scientific effort.

Except on the count of absence of provision for the social sciences, for which in Britain also no proper provision has yet been made in the national structure for research, it is difficult to see very much substance in Mr. Shepherd's criticism or any substantial difference between the National Science Foundation he advocates and the National Research Foundation of the Bush Report. His objections might equally have been raised against such a body as the University Grants Committee in Great Britain and still more against recent proposals for strengthening it. His paper shows a similar timidity regarding Government control to the timidity regarding business or industrial control which he mistrusts in the Bush Report, and the hesitancy of that report and of his own paper on these matters are probably to be attributed in part to the absence of an adequate Civil Service tradition in the United States comparable with that of the British Civil Service. To establish such a tradition, as the President's Report on Administrative Management has already observed, is one of the first tasks in the development of an effective organisation for government in the United States, whether concerned primarily with science or not.

The Bush Report is discussed from an entirely different angle in the next issue of *Science* by Dr. M. L. Tainter, director of research of the Winthrop Chemical Co. This industrial view of research trends covers much ground at present under examination in Great Britain by the Barlow Committee on the use of scientific manpower. Dr. Tainter stresses the way in which the rising cost of research has shifted the balance of research towards industry and made the most economic use of trained scientific workers a problem of the first order. Apart from the dangers of one-sided competition between the universities and industry for the services of outstanding men, Dr. Tainter refers to the estimated deficit of 16,870 in scientific personnel over the period 1941–55, given in the Bush Report as due to the diversion of scientific workers from research through the war effort, and states that it necessitates special measures by industry to meet a shortage which will require a decade to overcome.

No part of the Bush Report in fact deserves more careful scrutiny in Great Britain than that of the Committee on Discovery and Development of Scientific Talent, under Mr. H. A. Moe as chairman. For recent letters from the Imperial College of Science and Technology, published in *The Times*, London, indicate that the training of scientific workers and the opportunities for academic research are being needlessly restricted, and the intellectual resources of the country wasted by slavish adherence to regulations on the part of the Ministry of Labour and National Service. As was urged in the recent debate in the House of Commons on defence, the postponement of a definite decision on the period of conscription and age of call-up is causing waste which the country can ill afford.

Attention to these matters is one of the first steps towards the expansion of technical education at all levels; and it is to be hoped that the indication in the Bush Report of the vigour with which the United States is dealing with the matter of technical training and the supply of research workers will stir the authorities in Great Britain to fresh efforts and to a realization of the harm which its procrastination is doing to the productive power of the nation and to industrial development. The urgency of the matter is indisputable, and our resources of manpower are at best far too limited for us to contemplate without concern any avoidable waste of scientific talent. As Dr. Tainter observes, a large volume of research is not an adequate substitute for high quality and originality.

It is clear from the Bush Report, no less than from Mr. Shepherd and Dr. Tainter's articles, that American opinion is fully as alive to the changes and problems presented by the relations of industrial, academic and Government research as informed opinion is in Great Britain. There is a remarkable measure of agreement on the fundamental principles to be served: the importance of safeguarding the independence and freedom of the universities in any arrangements for joint research programmes and the like, and the importance of adequate endowment of fundamental research and of securing a balanced distribution of the ablest minds between the universities, industry and the Government service. What does appear to be lacking in both countries is the realization by men of science that the choice of form

of organisation to serve agreed scientific functions or fundamental principles may involve questions of public policy rather than of science, and as such should be left to the judgment of Congress or Parliament.

That point is well put by Prof. I. M. Kolthoff and Dr. M. B. Visscher in a note in *Science* on the bills for a National Science Foundation at present before Congress. It is not only in the United States that scientific workers may be called upon to realize that perfection is too much to hope for, and that a reasonably satisfactory arrangement is all one has a right to demand. The persistent emphasis on controversial points rather than on the large measure of agreement on objectives is a common cause of frustration; and although scientific workers are not the only section of the community who would do well to weigh the words of Sir Ernest Barker on this point in his "Reflections on Government", the neglect of others is no reason for their own indifference.

These observations on the Bush Report thus point to the need for a clearer understanding of the democratic process in much the same way as the studies at present in progress under Political and Economic Planning have done. This point is one of the most interesting that emerges from the broad survey of its programme for the immediate post-war years and of the philosophy and purpose which is guiding P E P work as a whole (Broadsheet No. 246: "A Programme and a Purpose"). Interesting as is the account the broadsheet gives of the two main categories of P E P work—the study of resources, and the study of motives—and the position reached in the various projects, the most significant feature is perhaps the way in which these studies of international trade, of Britain and Europe, of man-power, of the engineering industry, of fuel and power, and of population policy have induced P E P to make a frontal attack on the principal problem of motives in a democratic society by inaugurating a study provisionally called "Active Democracy".

A strong and energetic nation needs a sense of purpose which may be likened to the all-pervading air, the oxygen of which, unnoticed, enlivens and makes possible every form of activity. Can we reach a better understanding of this purpose without cutting across the principles of political parties, and without narrowing its range or detracting from its quality? These questions are raised particularly in the inquiries into man-power, which leads to a study of incentives, and also in these of population policy and of the trade unions, where we are led to consider the whole conception of democracy as part of the process, in a system of full employment in a mixed economy, of substituting a new motive and gaining a new understanding.

A study of active democracy would at least examine existing democratic machinery and see, first what vitality it had, secondly whether the machinery would be efficient in selected instances, and finally whether it was in fact speedy and efficient in most instances, and if not why not. It could examine, for example, the comparative value of the three different methods already existing for imposing a second democratic check on the action of the executive. It could consider whether each was suited for some specific type of administrative problem, and whether one was more democratic or more efficient than another.

To the modern mind, democratic society means something more than democracy in Parliament and in municipal affairs. It means that the whole of society should be pervaded with a democratic tinge. Only when the population as a whole abides by the basic assumptions on which its civilization is based can legislation and political machinery be effective; and legislation and political machinery are essential to protect society as a whole from any ignorant or vicious minority. The advance towards a fully democratic society may mean a system of preventing those essential controls from becoming arbitrary and authoritarian, a system of guarding against the abuse of necessary power, of preventing power over the individual will and conscience from slipping into private hands, from which it will have to be recovered by blood and tears. Society can relapse, and one of the problems of our time is so to design machinery that it will of itself tend to liberate rather than to relapse, to make safe each piece of ground won at each stage and to open up the prospect of further advance.

Political forms may in fact rarely have more than a temporary and local validity, and while in relatively undeveloped societies, as we do well to remember to-day, these forms will not necessarily look valid in any narrow sense, we must remember also that current political and social institutions require eternal re-assessment to ensure that they are not already restrictive or regressive. Even those instruments of vigilance, the free expression of opinion and the free press, need to be watched to see that there is no loss of the power to express opinion widely and in varied forms. It is against this background that we need to scrutinize our whole approach to planning.

Planning represents a national view of the direction in which society can best move. But when planning comes to recommendations for executive action, it must act not only in what may be termed the spirit of democracy but also by the method of democracy. Machinery must be chosen which is least likely to allow relapse, to allow power to slip into hands where it can be abused, or to turn the citizens of a nation into spectators rather than participants. This machinery should also push responsibility and initiative to the greatest possible extent downwards from the seat of power to regional organisations, to the parish and most of all to the individual citizen.

This may well involve utilizing to the full the rich experience of the voluntary organisations, both in the social and in wider fields; and the essays, edited by A. F. C. Bourdillon under the title "Voluntary Social Services: their place in the Modern State", which resulted from a study under the auspices of the Social Services Sub-Committee of the Nuffield College Social Reconstruction Survey, are a definite effort in that direction. We must utilize all those forces which strengthen the sense of duty rather than

of dues in the individual citizen. As inquiry into the facts proceeds, and as we acquire a sounder basis of comparison between the different forms which have been adopted for specific purposes and the apparent results of using those forms, it may be possible, as P E P suggests in its journal *Planning*, to lay down in much more detail a set of guiding principles, a list of rules for navigation in this largely uncharted sea, and a series of precedents and examples which will assist the legislature in choosing wisely.

No less emphatically than the *Economist* has done, *Planning* comes out in favour of the pragmatic, not the doctrinaire, approach. Many such choices will undoubtedly have to be made in the next five years. One has already been made in Britain for the coal industry, and another is proposed for the National Health Service. In other great departments of national life the necessity for improvement is recognized, and the duty of the State to formulate a procedure for that improvement is widely accepted. On the choice of form, however, few people are agreed, and few guiding rules exist. These choices when made will largely determine the quality and shape of great portions of our social and economic life for the next quarter of a century. Such considerations indicate the necessity for choosing forms which retain the greatest flexibility, and for more and urgent factual research on the lines which P E P is now following. This brief survey of its programme and purpose by *Planning* is indeed a powerful stimulus to constructive thinking about these vital and urgent issues; and its appeal is strengthened by the fact that, so far from any attempt being made to prejudice the issue, the emphasis is on the selection for a defined task of the organisation and forms which will most effectively serve the human need rather than that of doctrine. The study of 'active democracy' and of the ultimate aims, processes and forms of planning promises to issue in one of the most important contributions to the achievement of the democratic ideal and of a new social and international order that P E P has yet made.

CHEMISTRY OF CELLULOSE

The Chemistry of Cellulose

By Emil Heuser. Pp. v + 660. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1945.) 7.50 dollars.

THE elucidation of the ring structure of the simple sugars paved the way for rapid advances in our knowledge of the chemistry of the complex polysaccharides, and nowhere has this progress been more pronounced than in the study of the chemistry of cellulose. Here, by the utilization of both chemical and physical methods of approach, evidence has been accumulated which enables us to picture the cellulose molecule as a long chain of β-glucopyranose residues glycosidically linked through their first and fourth carbon atoms. This formulation has become generally accepted, but it must not be forgotten that it is no more than a general outline, and that most of the finer details of the structure still await elucidation. It has to be recognized, for example, that the detailed shape of the molecular chain, as inferred for some years from the X-ray data, was probably not correct; and in spite of recent intensive efforts, it is still not possible to determine exactly the disposition of each atom in the cellulose structure. There is hope, however, that the work of Cox and his school on the simple sugars, in conjunction with Astbury's recent discovery of a new configuration in polysaccharide chains, may result in very considerable refinement (see *Nature*, 157, 123; 1946). The latter work appeared too late for its discussion in Dr. Heuser's book; but his chapters on the microscopic and submicroscopic structural arrangements in the cellulose fibre serve to illustrate the difficulty and complexity of the problems which remain to be solved before the gap which exists between the biological and the chemical approaches to the study of cellulose can be bridged. These chapters are well illustrated by striking photomicrographs which would, however, have been still more useful if the degree of magnification had been included in each case.

It is a natural step from a consideration of the organised colloidal structure which is present in a cellulose fibre to a discussion of the reactions of cellulose with water and then with aqueous alkalis. These two chapters are followed by an account of the interactions between cellulose and organic bases, ammonia, and concentrated salt solutions, leading up to the chapter on the action of cuprammonium hydroxide. A detailed account of the chemistry of the cellulose esters, including xanthates, occupies almost a third of the volume. Next in order comes a chapter on the cellulose ethers, and this is followed by an extensive treatment of the oxidation phenomena displayed by cellulose. There are chapters on the decomposition of cellulose by acids and by heat, and an interesting account is given of the decomposition of cellulose by biological processes. Finally, the volume is rounded off by two chapters in which a concise summary is given of the work bearing on the chemical structure of cellulose and on the molecular weight of the native material and of various degradation products.

The material contained in these chapters serves to give the reader a comprehensive review of cellulose chemistry in which special emphasis has been laid on underlying scientific principles rather than on practical industrial applications. The result is an extremely readable book in which the information is presented in such a systematic way that interest is maintained throughout; and although the literature reviews carry the story up to October 1943, the reader has no feeling of being overwhelmed by a mass of detail. Dr. Heuser presents the current knowledge in a balanced and critical form well suited to the student who wishes to use the volume as a general text-book of cellulose chemistry.

There are a few obvious slips which can easily be remedied in a future edition. For example, an account is given on pages 36 and 37 of the interesting observations of Bois and Chubb concerning the formation of cellobiose in the sap of the birch tree, probably by enzymatic action on starch as substrate. It is suggested that unless the formation of cellobiose is the result of a re-arrangement of maltose under the action of specific enzymes, these observations should lead to a revision of the molecular structure of starch. The caveat could well be much more strongly worded, since the presence of maltose residues in starch is so firmly established by the chemical evidence that it would take much weightier evidence than the mere

formation of cellobiose in complex enzymic systems to cast any doubt on its accuracy. On page 415, over-compression has led to a serious misstatement concerning the acetolysis of trimethyl cellulose, which is said to yield 15 per cent of tetramethyl methyl glucoside. This is clearly a slip, and it is to be noted that correct interpretations of these experiments on the acetolysis of methylated cellulose are given later in the book (page 573) when the chain structure of cellulose is under consideration. In the course of a discussion on the degradation of methylated cellulose by ultra-violet light, end-group figures are quoted as percentages to four places of decimals, an accuracy which is quite beyond the present power of the experimental method. There need be no surprise, therefore, over the divergence, commented upon by the author, between the estimates of the degree of polymerization derived respectively by the end-group and by viscosity methods.

These are minor points, however, and the author is to be congratulated on the presentation of such a clear and readable account of an extremely complicated subject.

E. L. Hirst.

PEAKS OF CREATIVE ACTIVITY IN SCIENCE AND THE ARTS

Configurations of Culture Growth

By A. L. Kroeber. Pp. x+882. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1944.) 7.50 dollars.

THE author has made many notable contributions to the study of social evolution among both pre-literate and literate peoples, and has championed the need for special study of the latter. His life-work at Berkeley, University of California, is being recognized this year by the award of the Huxley Memorial Medal of the Royal Anthropological Institute. He builds, in the work under notice, around catalogues of leading names in philosophy, the sciences and the arts to show that, in all lines of work, florescence occurs in spurts now and then, often with a whole constellation of great masters. He has no doubt taken counsel with specialists so as to set forth widely accepted lists of leaders, especially those marking the apices of florescences, while acknowledging that a subjective factor inevitably comes in, as it does in all our work. The fact that even science, which is inherently cumulative, has its periods of blossoming, is well brought out, as is the sharpness of development and the shortness of major blossoming in dramatic art—the end of the sixteenth and the beginning of the seventeenth century in England, the years around the middle of the seventeenth century in France are notable examples. The apex of florescence in philosophy is, on the other hand, apt to come late, after a longish preparation, an interesting and understandable fact.

As an illustration of the difficulty of selection in these lists, one may instance that Bergson is included, but neither Alexander nor Lloyd Morgan. Then, in the chapter on music, J. S. Bach is described as the precursor of the great (mainly Viennese) constellation—Handel, Glück, Haydn, Mozart, Beethoven, Weber, Schubert; though Kroeber is puzzled over the flourishing of Bach in the period around 1725 when, as he rightly says, there seems to have been a slowing of artistic production. The reviewer asked some students of music, and found they considered Bach the final culmination of contrapuntal music, and thought he remained almost without influence until Mendelssohn compelled the world to listen to him. Handel was his contemporary, and both came from Protestant Germany, and are very different from the stream which flowed through Vienna, though Handel was more related to this last than was Bach.

It is not for a layman to try to arbitrate between these opinions; they are given merely to illustrate the difficulty of decision in this type of question, or in that of the 'country' to which a pre-modern master is to be supposed to belong culturally. For the days of the classical education, Western Europe might for some purposes be considered as one. Kroeber shows that florescences in different fields of work are apt to occur together, and here one of the great instances is Holland, in the period of its wealth, commerce and power in the seventeenth century. Rembrandt and the galaxy of painters, Grotius in law, Spinoza in philosophy, Huyghens and Leeuwenhoek in science make a brave show. The author might have added a hint that Holland had received refugees for generations, and had developed a respect for thought and a measure of freedom of conscience. But he wisely argues that there is no necessary gathering of these blossomings; indeed he lays great stress on the need for considering each case, and on the danger of trying to enunciate general laws. "The wind bloweth where it listeth."

The details of the many catalogues in this book will stimulate readers to think out alternatives; and this is all to the good. One knows of so many cases of workers, neglected in their life-time, who afterwards have been recognized as masters; and still more cases of those who loomed very large while alive but whose work has not lasted. It has been a service to make these catalogues, and to encourage a study of these blossomings of art and thought.

H. J. Fleure.

CHEMISTRY AND INDUSTRY

What Industry Owes to Chemical Science

Third edition, based on the scheme of the first and second editions by Richard B. Pilcher and Frank Butler-Jones. Pp. viii+372+13 plates. (Cambridge: W. Heffer and Sons, Ltd., 1945.) 18*s*. net.

THE mere expansion to its present size of the slender volume which contained the original twenty articles issued in 1918 gives a striking measure of the scale on which the contribution of chemistry to industrial progress has expanded during that period. Allowance must be made for a considerable amount of overlap and repetition in the different articles, but against this there are some surprising omissions. Industries such as aviation and the electrical industry pass unnoticed, and the synthetic fibres scarcely receive the treatment that is their due, nylon in particular being barely mentioned. The treatment of both textile and of synthetic resins or plastics is sketchy. Although detergents and like compounds are discussed in two articles, the water-repellent finishes and the crease-resistant treatments appear to have been overlooked. Only an incidental reference by Mr. Silvester and by Dr. Dunstan gives any hint of the importance which petroleum and acetylene have now come to assume as the raw materials of organic synthesis.

As might be expected, with more than fifty contributors in place of the original two, the book has lost some coherence. The excessive overlap can scarcely be charged against the contributors, and could have been avoided by more careful planning. For example, Mr. C. H. Hampshire's article on drugs is largely repeated in Dr. F. H. Carr's article on technical and other chemicals, in which Mr. McLachlan's article on disinfectants, antiseptics and preservatives could also well have been included. The discovery of mercerization is described at length both by Mr. F. Scholefield and by Mr. J. H. Lester, and other examples could easily be cited. Some of the repetition may be due to the excessive sub-division of the various chapters, but part at least may be attributed to the approach adopted of looking at chemical science from the angle of two score or more different industries in turn.

Whatever lack of unity the third edition may display as compared with the first, however, is more than outweighed by the new information included. Furthermore, comparison of the two editions shows strikingly how the importance of chemistry in industry has shifted from the mere analytical control of the purity of raw materials or products to that of the development of new processes or products, the improvement of existing ones or the provision of alternative routes to an existing product. The volume also contains sufficient incidental, historical information to give it a place alongside Miall's "A History of British Chemical Industry", which indeed in some respects it supplants. Most of the essays have brief but adequate bibliographies, though some of them could well have been improved by including at any rate the years of publication.

There are some lapses even here. Mr. J. Sanderson gives a clue in his final paragraph as to why no bibliography completes his essay on pencils; but Mr. Scholefield, who covers much ground in common with Mr. Silvester, cannot plead the same excuse. Incidentally, Mr. Scholefield should not expect the ordinary reader to interpret correctly his statement regarding the output of dyestuffs in Britain as relating to weight and not value. Similarly it seems unnecessary to introduce without explanation for the non-technical reader the term *p*H into a most readable account of the laundry industry. The explosives section is reprinted with only slight modifications from the original edition; all the more reason for adding to its bibliography a reference to Prof. John Read's little volume on explosives (1942), particularly in view of the general reader to whom the whole volume is addressed. Again, it is not correct to describe or classify Monastral Blue as an inorganic pigment, as Dr. Keeman does by implication in an otherwise admirable essay on paint and varnishes.

Many of the essays are excellent, but some at least of the contributors might have shown a clearer conception of the purpose of the volume and the reader to whom it is addressed, even if we could scarcely expect them all to display the freshness of outlook and facility of exposition which characterize Mr. Silvester's outstanding article on dyestuffs. That is no simple theme, but no reader of Mr. Silvester's essay should be in any doubt as to the part which the chemist has played in the development of the dyestuffs industry or the relation of that industry to a score of others. It may be true that the relation of the dyestuffs industry to chemical science is so intimate that there is relatively little difference in angle whether one looks at the subject from the point of view of chemistry or of industry; but there is room for many more contributions on the high level of exposition which Mr. Silvester displays in this essay.

The book is well produced, and the Royal Institute of Chemistry is to be congratulated on re-issuing a book which should find a welcome place on the chemist's bookshelf, in the college and university library and in more general libraries. It is well fitted to meet a need which the expansion of technical education should stimulate. R. BRIGHTMAN.

BIOLOGY OF TWINS

Biologie des Jumeaux (polyembryonie et gémellité) Par Prof. Maurice Caullery. (La science vivante, No. 6.) Pp. 168+4 plates. (Paris: Presses universitaires de France, 1945.) 80 francs.

IT is rather surprising that in spite of Nazi occupation a number of scientific books were published in France during the War; only now are they becoming obtainable in Britain. One of the more interesting biological publications is this study of twins by Prof. Caullery, whose encyclopædic knowledge enables him to bring together a wide range of examples drawn from very diverse groups of animals.

The author first emphasizes the essential difference between twins resulting from the development of distinct eggs, with distinct chorionic membranes; and those resulting from the division of a single egg, therefore having only one chorion.

Twins of the first group do not differ essentially from brothers and sisters born successively; they may be of different sexes, and also present the usual differences found in any particular family. Twins of the second group, on the contrary, are often known as identical twins, since they are always of the same sex and closely resemble each other. Moreover, they arise from a single ovum, and both are enclosed by the same chorionic membrane. These are the real twins; and with the object of throwing light on their origin, the first part of the book is devoted to an account of the experimental doubling of the embryo with special reference to vertebrates. This is followed by a review of polyembryony in both invertebrates and vertebrates.

The second part deals with the production of twins in man and domestic animals and a discussion, with many examples, of the use of uniovular twins for the study of heredity. An appendix to this section contains an account of Zawadowsky's experiments in the U.S.S.R. on the production of increased fertility in sheep and cattle by the injection of hormones. This method has been applied with great success to millions of sheep, especially of the caracul race, and more than half of those treated gave birth to two or more lambs. Incidentally, in order to convince the shepherds of the practical value of injections, Zawadowsky wrote a special "Life of Pasteur" for their use.

The third part comprises an account of teratological twinning, and includes many examples of double monsters. It is followed by a general discussion of the whole problem. The bibliographical references at the end of the book add to the value of this excellent introduction to an interesting subject.

EDWARD HINDLE.

MATHEMATICS IN GOVERNMENT SERVICE AND INDUSTRY

SOME DEDUCTIONS FROM THE WAR-TIME EXPERIENCE OF THE ADMIRALTY COMPUTING SERVICE*

By D. H. SADLER and JOHN TODD

IN 1942, Prof. J. A. Carroll, shortly after joining the headquarters staff of the Director of Scientific Research in the Admiralty as assistant director, saw that scientific effort in the Admiralty establishments could not be fully employed in its proper field because scientific men were having to undertake their own computational work. Often, for lack of training in computational mathematics, they spent even more time on this than it needed intrinsically and, more serious still, for lack of internal or external facilities, some investigations requiring extensive computations were foregone. An investigation of the computational needs of establishments by Mr. D. H. Sadler, superintendent of H.M. Nautical Almanac Office, was accordingly arranged. Earlier, the Nautical Almanac Office had been doing large-scale computational work for other Government departments, notably the Ministries of Aircraft Production and Supply, in addition to its navigational work for the Air Ministry; proposals for an inter-departmental computing organisation which had been made earlier by the Office were overtaken by the joint proposals, referred to later. Following Mr. Sadler's report that a considerable amount of computational work could with advantage be centralized, a mathematical section was set up in the Department of Scientific Research and Experiment to deal with this work and with the more difficult mathematical problems which were known to arise in naval establishments and which were being either set aside or tackled by totally inadequate methods. This section became known as the Admiralty Computing Service. Mr. John Todd was responsible for organisation and supervision of this Service. Staff were attached to the Nautical Almanac Office to carry out the actual computations under the direction of Mr. Sadler, and arrangements were made whereby scientific workers in the universities and elsewhere could be employed as consultants.

It was soon found desirable to inform members of establishments of techniques in pure, applied and numerical mathematics with which they were unfamiliar, so that they could deal with problems unsuitable for centralization. To this end a series of monographs has been prepared for distribution to establishments on such topics as steepest descents, Laplace transforms, conformal representation, etc.

At the end of the War, the Admiralty Computing Service was providing a fairly comprehensive mathematical and computational service which was not only meeting all demands from Admiralty sources but was also able to offer informal assistance to the other Services, Government departments and contractors who had no comparable facilities at their disposal. In view of the widespread interest shown, it has been considered useful to put on record, for the benefit of other organisations, some of the experience gained.

In the first place, even an organisation as large as the Admiralty Department of Scientific Research in war-time could not fully justify the establishment of a *comprehensive* computing service. For example, such a service might expect to have available a differential analyser and a complete Hollerith installation; for the first of these, in three years, there was no requirement, and a Hollerith installation would not have been in use for more than about two months a year. Although this is largely due to the relatively poor field for centralization of computation (though not of mathematics, as such) provided by a research organisation, it was quickly realized that nothing less than an organisation on a national scale could be both comprehensive and efficient, especially in peace-time. The Department of Scientific and Industrial Research was therefore asked to consider the formation of a permanent National Mathematical Laboratory. Discussions, in which the unique experience gained by the Admiralty Computing Service played an important part, have now resulted in the formation of a Mathematics Division of the National Physical Laboratory. It is hoped that this new organisation will be able to render efficient service to small groups with problems for which complicated equipment is necessary. In this connexion our experience fully confirms the statements made on many occasions by Dr. L. J. Comrie, of the Scientific Computing Service, Ltd., that full exploitation of the capabilities of the commercial calculating machines (including the National accounting machine and the Hollerith) is usually the most efficient way of dealing with problems, and specially designed calculating machines and instruments are necessary only for large-scale investigations of infrequent occurrence.

As regards recruitment and training of senior computing staff, war-time difficulties merely accentuated the shortage of experienced computers. With but a few exceptions, there is no academic training in computing, though it is noteworthy that the universities are recognizing the claim of computational mathematics for inclusion in both graduate and post-graduate courses. But skill in computing requires more than theoretical knowledge; it requires the practical experience that can only be gained in a computing establishment. It is therefore to be hoped that it will be found possible to allow suitably qualified graduates to obtain that experience in, for example, the Mathematics Division of the National Physical Laboratory. A warning must, however, be sounded; the demands made on a practical computer, especially when responsible for non-systematic work arising from research rather than from application, far transcend any that examinations may make. A computer's task is to obtain the correct result of a practical problem, if possible the first time and by the most efficient method, and to know that he has done so. Our experience confirms our previous view that only the really first-class man or woman, possessing natural aptitude as well as acquired knowledge, will be efficient; anyone less will by his mistakes more than cancel his positive contributions; computing, in fact, holds no place for the mediocre and little for the average. So much for senior computers; as regards junior computers with or without degrees, we can only stress what has been said often before*, that the essentials are intelligence and interest, nurtured by comprehensive special training; computing cannot adequately be 'picked up' in the course of day-to-day work.

* This article is published with the permission of the Director of Scientific Research, Admiralty, and the Astronomer Royal. Details of work carried out by the Admiralty Computing Service and the staff concerned are being presented in an article to be submitted to the journal *Mathematical Tables and other Aids to Computation* published by the (U.S.) National Research Council.

* See, for example, Comrie, L. J., "Careers for Girls", *Math. Gazette*, **28**, 90 (1944).

Much of what has been said about computational needs is applicable to mathematical ones also, and here there is the additional factor, generally agreed upon, that the conditions of work in the Civil Service are not the most suitable for mathematical research. Perhaps the best way to deal with this problem is to make use, as consultants, of members of university staffs; in particular, of those who have had experience in industrial mathematics during the last few years. This can only be done satisfactorily if there is available, to co-ordinate the demands, and to act generally as a liaison officer, a fully qualified mathematician, sufficiently free from routine duties that he can keep himself up to date in the current developments of mathematics.

Another point driven home by experience is the fact that in many cases the use of 'advanced' pure mathematics can save the computer much time. Not always is the elegant general solution produced by the pure mathematician the one most convenient for the computer, but very often such solutions can be used to provide perfect checks on the work. Details of a special problem, which has had some publicity in virtue of a rather spectacular success in the reduction of the work involved from an estimated 300 years to 50 hours, may be of interest. As the problem was received, the estimate of three hundred years was for the solution of a certain integral equation based on computing from the general explicit solution in terms of the iterates of the kernel. By solving first the integral equation for the resolvent and then the resulting integral equation by step-by-step numerical methods a solution was quickly found which is, however, subject to accumulation of error and to the chance of accidental errors; the magnitude of this error was determined by using the Laplace transform theory to obtain a formal integral representation of the solution, which could be evaluated directly at the end of the range—this whole process involving only fifty hours work. Another example was the checking of results obtained by relaxation technique by use of a generalization due to Dr. A. P. Guinand of the Poisson summation formula.

There has been a feeling among computers that their art is so highly specialized that little good can come from collaboration with mathematicians who have not served a long apprenticeship. We have not found this to be the case: a first-class mathematician can quickly pick up the broad principles of computation and may make important contributions to this subject without being able to carry out the detail of the numerical work. For example, the problem of determining numerically the characteristic frequencies of a dynamical system with a large number of degrees of freedom was referred to a mathematician whose field was abstract analysis and who was completely ignorant of numerical mathematics. In a very short time he was able to produce a new iterative process for the calculation of the quantities in question which computers, familiar with the standard methods, consider to be extremely promising.

On the other hand, it cannot be emphasized too strongly that the computer must be the ultimate judge of the methods available for solution; he has to obtain certain numerical values, and mathematical elegance may spell drudgery for him. For example, a mathematician probably considers that the functional solution of a naturally occurring differential equation represents a significant advance towards its numerical evaluation; but in many cases the direct numerical solution of the differential equation offers a faster and more certain method than evaluation of a complicated function. This is particularly so in potential theory, where the relaxation method, in the hands of an experienced computer with both skill and insight, can be used with great power, and where functional representations, however ingeniously devised, are necessarily so complicated that the calculation of a single value (as an independent check, for example) involves as much work as the complete solution by more direct methods. It must not be forgotten, however, that the theoretical method may give directly valuable information about the behaviour of the solution; and that in general the average time for solution, for differing values of the parameters involved, is constant for direct methods but diminishes rapidly when an explicit solution exists. Efficient computing demands the fullest integration of all available mathematical and computational techniques.

One of our most serious difficulties has been in obtaining a precise statement from the 'customer' of the problem he requires solved. This is particularly noticeable in connexion with statistical problems. Experience has shown repeatedly that a reduction 'to a form suitable for computation' has covered up the essential nature of the problem; or that approximations (and errors !) in the theoretical development have rendered nugatory subsequent computation. It might be mentioned here as a broad generalization that although arithmetic is sometimes checked, complicated algebraic manipulation is rarely checked prior to its use as the basis for the statement of a problem. It is most desirable, therefore, for the computer personally to see the 'customer' and to discover what he really wants. Slavish adherence to the principle of the 'customer's' infallibility will result in much wasted labour !

We consider that it would be more advantageous to show the potential 'customers' of the mathematician, to whom we shall refer as engineers, the types of problems the mathematician can help them with, and how to state a problem precisely, rather than to give them a smattering of various mathematical techniques. In particular, we think that, while very short courses on the theory of errors are of use to engineers, anything less than a proper study of statistics is worse than useless in general. We would suggest that the time devoted to short courses in statistics would be more profitably employed in a survey of the principles of computation—in the applications of these principles things are in general self-checking and improper applications will show themselves, which is not necessarily the case in statistics. Such a survey could be given in an hour a week for a term with the appropriate example times; it is realized that this will not make the listeners into trained computers, but very few students of science will become professional computers whereas almost all will have to interpolate in tables, do simple calculations and state problems for specialists to undertake.

Concurrently with this suggestion that the engineer should learn to state his problems precisely, we must ensure that the mathematician is able to tackle these problems. We maintain that this industrialization of mathematics is a postgraduate process: it is not possible to lower the current academic contents of degree syllabuses to allow for the introduction of really applicable mathematics. What is required is courses similar to those given in some American institutes during the War; for example, the courses

at Brown and Columbia Universities, which received support from Government and industry. In addition to providing instruction in the necessary techniques, it will be necessary to indicate the existence of unsolved problems in industry which can lead to interesting mathematical developments. While it is hoped that those mathematicians who have been engaged on engineering problems during the War, having realized the unsuitability of their university training for such work, will, on their return to academic life, adapt the courses accordingly, this will not deal with the whole problem. Since the principle of the sabbatical year has not been accepted in the new Scientific Civil Service and in view of concentration of industrial research associations within reach of London, it would appear desirable and opportune for the University of London to provide suitable postgraduate courses.

THE EGYPTIAN ACADEMY OF SCIENCES

By A. M. MOSHARRAFA PASHA
Dean of the Faculty of Sciences, Fouad I University, Cairo

EGYPTIAN men of science have for some time felt the need for establishing an academy of sciences in Cairo. So far the bulk of research work carried out in Egypt has been published in foreign journals or communicated to learned societies abroad. Although the Institut d'Egypte was founded in 1859 (reviving an older institute founded by Napoleon) and counts among its four sections one for Physical and Mathematical Sciences and another for Medicine, Agronomy and Natural History, its main tendency remained literary and artistic. Thus we find Osman Ghaleb Pasha (1845–1920), the biologist, publishing his work on the migrations of *Filaria rytipleurites* in the *Comptes rendus* of the Paris Academy in 1878. Previously Mahmoud El Falaki Pasha (1830–85), the astronomer and physicist, published his work on terrestrial magnetism in the *Comptes rendus* of the Paris Academy (1856) and the *Mémoires couronés et mémoires des Savants étrangers* of the Belgian Academy (1856).

With the establishment of the Fouad I University in Cairo in 1925 scientific research in Egypt received a strong impetus. Thus from the Faculty of Science alone more than five hundred papers have already appeared embodying the results of original researches in different fields of pure science. Of these, nearly 350 papers have appeared in scientific journals and proceedings of learned societies abroad (with more than two hundred papers in British journals). The rest, representing only about 30 per cent of the total, were either communicated to learned societies in Egypt or published as bulletins or special publications by the University of Cairo. Other Faculties, such as Medicine and Engineering, have contributed to the growth of pure science in addition to their work in the fields of applied science.

Mention should also be made of scientific and technical departments of the Egyptian Government, such as the technical departments of the Ministry of Agriculture, the Physical Department, etc. These publish their researches as a rule in the form of Government bulletins. The Helwan Observatory publishes special reports. Other noteworthy publications are the "Flora of Egypt" (Vol. 1, Pteridophyta, Gymnospermæ and Angiospermæ; Part 1, Monocotyledons: Typhaceæ-Graminæ), the tables of Legendre associated functions (with fifty thousand entries) and the special publications of the Marine Biological Station at Hurgada, all of which have been published by the Faculty of Science of the Fouad I University. In addition to the Institut d'Egypte referred to above, the following learned societies, among others, issue publications:

(1) The Fouad I Entomological Society, founded in 1907 and given its charter in 1923 (*Bulletins* and *Mémoires*).

(2) The Royal Geographical Society of Egypt, founded in 1875, re-organised in 1917 (*Bulletins* and *Mémoires*).

(3) The Mathematical and Physical Society of Egypt, founded in 1936 (*Proceedings*).

(4) The Egyptian Royal Medical Association, founded in 1919 (*Journal*).

The establishment of the Egyptian Academy of Sciences is thus a natural step in the development of scientific activities in Egypt. Following upon a number of preliminary meetings, the Academy was formally instituted in 1945. The Council consists of ten members representing the different branches of science (three for mathematical, physical and astronomical sciences, one for chemistry, five for the biological sciences and one for geology). The first scientific meeting of the Academy was held in April 1945, and monthly meetings are held on the first Tuesday of every month excluding the period from June to September. The first publication of the Academy is in the press and will appear shortly.

Reference should be made to the Royal Prizes in Science which have graciously been founded by His Majesty King Farouk. These consist of four annual prizes each of value £E. 1,000 (about £1,025), to be awarded for the best contributions to the progress of science. The prizes are one for mathematical and physical sciences, one for biology, one for chemistry and one for geology. A committee, presided over by the Minister of Education, has been appointed to consider the conditions for awarding these prizes.

GEOLOGY IN SCHOOLS

AT a meeting on April 5, the Geologists' Association held a discussion on "Geology in Schools". The weight of opinion seemed to be that geology, at any rate up to the higher certificate stage, should usually be worked in as a side-line rather than included as such in a syllabus, but that much more should be done in this way than at present. The Association is peculiarly fitted to discuss such a proposition, since it includes in its membership many to whom the science remains a side-line or hobby. Among those who were present and spoke or had sent in written contributions were headmasters of schools, school teachers of both sexes, museum curators, university teachers and others with practical experience, while among members present were several who are still at school; one of these last has since sent in an account of the difficulties he encountered when seeking to take geology as a subject for the higher certificate examination: it forms a clear first-hand statement of the position, which needs to be remedied.

It is the intention of the Council of the Association to condense the contributions, already numbering more than two dozen, into a comprehensive report to be circulated to educational authorities and be placed on sale to non-members.

The Desirability

Geology is, in a sense, a fundamental subject, but is in turn dependent on physics, chemistry, mathematics, zoology and botany; an acquaintance with it ensures a wide basis in general science, essential if future specialists in a narrow field are to be valuable members of the community. It is unrivalled, if wisely handled, as a training in observation; for example, one schoolmaster mentioned that he would only identify specimens found by pupils if a clear statement of the exact locality was forthcoming. Not everyone, nor even every science pupil, need learn much geology, but at present there is a widespread ignorance of the scope and potentiality of the subject. Actual instances were alluded to, where research chemists, called upon to deal with mineral substances, showed complete ignorance of the fact that a geologist could tell them not only what elements, but also what compounds were present. Civil engineers and architects have sometimes failed to recognize the need for a geologist's opinion, but there has recently been much improvement in this respect.

Pupils found to be decidedly dull in normal classroom subjects often show great keenness when introduced to elementary field geology, and develop an interest and ability which, when once aroused, can be applied also to form-work in this and other subjects. A very strong case can and will be put together from the contributions to the discussion for making instruction in geology available before a pupil leaves school.

The Opportunity

There are few subjects to which geology is not to some extent relevant; physical geography is obviously directly dependent on geology, but several members pointed out that it is undesirable to treat geology as a part of geography, which is better regarded as one of the humanities than as a science. It is more and more realized that geography in turn is a necessary background to history. The 'father of history', Herodotus, included in his work much geography and a by no means insignificant amount of geology. Classical pupils are taught that the battle of Salamis was won by the use of the new silver coins known as 'Athenian Owls'. Are they taught where the silver came from and how it was obtained? They can read it in Demosthenes, if the more intentionally scientific works of Strabo and Pliny are not sufficiently 'pure' in language. If we teach the influence of resources of coal and iron on modern history, should not something be said about those substances? Elementary chemistry can be made much more attractive if specimens from mines or quarries are substituted for bottles from a shelf. One speaker said he had introduced geology through solid geometry and optics, teaching crystallography and petrology, and rather scorning the collecting of fossils from quarries near his school; his views met with little support. A woman-teacher mentioned that she had recently given young children a lesson which began on Psalm civ and ended in geology!

Advantage should be taken of the collecting instinct, which shows itself in almost every child at some time. A master at a public school in the north of England gave the most usual age for boys as twelve-and-a-half to fourteen; but the president said that he himself developed it at the age of five and had not yet outgrown it at sixty-one. Collecting fossils and minerals has nearly all the advantages and none of the disadvantages of the other usual manifestations of the instinct: it affords admirable training in observation, both in recording the place and mode of occurrence in the field and in detecting specific differences indoors. The collecting of birds' eggs is wholly destructive; that of insects and plants undesirable if or when it reaches a stage where rarities are affected. Neatness and orderliness can be inculcated in arranging a geological collection as easily as one of stamps.

A remarkable instance of what can be done even in a country elementary school was given by the first speaker, Dr. Vernon Wilson, at whose suggestion the discussion was held. When working in a quarry in Corallian limestone, he had laid out on the grass all the fossils he had found. Three small boys, aged about ten, came up and gave him correctly the Latin generic and specific names of all his specimens, and told him how the fauna there differed from that in a nearby quarry showing a slightly different facies. Incidentally, they could also name correctly the butterflies and moths they had collected. In Leeds he had known boys from a secondary school able to name the ornamental stones used on the front of public houses and other buildings in the street and to say whence they were brought. Such instances serve to show what can be done by an enthusiastic teacher. The raising of the compulsory school age by one year gives additional opportunity; but are there the teachers able to turn it to advantage?

The Means

The first essential for an improvement in the teaching of geology is, of course, a sufficiency of teachers capable of giving elementary instruction and cognizant of the methods of pursuing geology at further stages and of the ultimate prospects as a career. Little or no indoor apparatus is necessary in primary schools, and not much in secondary schools. Prof. A. E. Trueman, president of the Geological Society, who has already taken the lead in much work on this subject, stressed the need for a really attractive and sound book on geology for young people; no one is better fitted to supply the need than himself.

Opportunity for outdoor work is essential, but must vary greatly with the type of school. The class already mentioned, that started on petrology and crystallography, was taken for a fortnight's holiday trip to the Isle of Arran: a primary school in the poorer parts of London is almost dependent on museum visits—not quite, since the roof and walls of the school and other buildings, the pavements and roads, the fuels for home, factory and transport afford many openings for attractive lessons on subjects of which every voter should have learnt something. One headmaster, with plenty of geological interest at hand, pointed out that he was bound to give to the local education authority a fortnight's notice of any lesson to be given outside the walls of his school; but no weather forecast is yet available a fortnight ahead. Here a simple reform is obviously necessary; a quota of time, varying, perhaps, with the type of school and the locality could be assigned with freedom of adaptation to the weather; a reasonable grant for expenses should be available. A visit to a quarry may afford many opportunities

for instruction besides those directly geological. The measuring of a face, actually or assumed to be inaccessible, is practical geometry; the drawing of it involves perspective; there may be some plant-geology for botanists and so on.

The assistance of local museums is essential and can be greatly developed. Dr. F. J. North, of the National Museum of Wales, sent a valuable account of his work in this way. A contribution also came from Mr. H. E. Dudley, of the Scunthorpe Museum; a locality where almost every inhabitant is directly dependent on geology for employment has obvious advantages in this respect.

One of the speakers chosen by the Council, Dr. R. O. Jones, was formerly guide-lecturer at the Museum of Practical Geology. It is essential for London school-children that this Museum should be reopened at the earliest possible moment, and that the courses of instruction for teachers should be resumed. For schools everywhere it is important that geological maps should become obtainable with the minimum of delay. C. N. BROMEHEAD.

TRANSPORT OF WATER AND SALTS THROUGH PLANT TISSUES

By PROF. H. LUNDEGÅRDH
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ACTIVE salt absorption is a fundamental characteristic of the living cell. In tissues and whole organisms the active transport of salts from specialized absorption organs to other parts of the body is clearly a matter of fundamental importance. The cellular mechanism of active transport of water and salts is probably similar in plants and animals; but plants are in several respects more convenient objects for experimental investigation.

Absorption of Ions in the Surface of the Protoplasm

From studies of the potential difference between a root system and the surrounding solution at varying hydrogen ion concentrations of the latter, it was concluded that[1] the plasma membrane holds a comparatively strong high molecular acid (symbolized as $H^+R_a^-$), its pK amounting to 1–2 and concentration to 10^{-3}–10^{-4} N. Also weak bases are obviously present, but the acid dissociation dominates, resulting in a normally negative potential difference. The surface of the protoplasm thus behaves as a complex mono- or multi-layer, the dissociated components forming a sparse mosaic in a neutral ground substance. The strong acid is probably identical with nucleotides (adenylic acid[2]) which are given off in small quantities from living roots. The nature of the ground substance and of the base is unknown. Proteins are not exuded from roots, and phosphatides are probably not present in the plasma membrane.

In contact with a very diluted acid the large anions R_a^- are combined with H-ions. In contact with a solution of a neutral salt M^+A^- the H-ions are exchanged for M-ions. The reaction $HR + MA \rightleftarrows MR + HA$ approximately obeys the law of mass action[3], but hydration of the ions and the adsorption coefficients influence the equilibrium. A similar exchange is to be assumed in respect of the anions of the medium. Owing to the negative potential difference (in wheat roots normally amounting to $c.-60$ mv.) the cations are positively adsorbed on the surface of the root, whereas the anions are negatively adsorbed, that is, are more diluted than in the medium (Donnan equilibrium).

Accumulation and Transport of Cations

Metallic cations in the medium are exchanged for other metallic cations in the root tissue, a process which implies a non-polar movement of ions[4]. It occurs also under anaerobic conditions. The general principles of exchange-power, well known from soil colloids, are valid for root tissue; but the complicated structure of the living membranes sometimes creates almost complete impermeability for special cations (for example, sodium). Cations are shown as moving from negative points in the surface to negative points in the bulk of the protoplasm, partly by a 'turning over' of large anions, partly along 'adsorption tracks', that is, ionized chain molecules (Fig. 2). It is to be supposed that mineral ions afterwards move much faster than would be possible by diffusion only. Metallic cations of course accumulate in each structural unit which develops a corresponding adsorption potential. But an accumulation of metallic cations *as free salts* postulates the simultaneous accumulation of free anions. So far as such ions are produced in metabolism, cations also accumulate in the cell sap independently of an active uptake of anions from the medium. Such anions are HCO_3 and organic acids, for example, malic acid, which plays an important part in the regulation of the internal pH of cells[4]. If malic acid disappears again in respiration a corresponding quantity of metallic cations (for example, K^+) are exuded from the tissue.

Accumulation and Transport of Anions

Accumulation of inorganic salts in a cell or a tissue is the result of metabolic processes. According to the theory of 'anion respiration' a special respiratory system meshes into the active uptake and transport of anions. The theory is based on respiration experiments with a large variety of single neutral salts in the medium[4]. In these experiments not only the absorbed quantities of anions and cations were determined but also the quantity of exchanged cations (anions are normally exchanged only to a very small degree). In plotting the absorption of anions against the respiration, expressed as carbon dioxide evolution, the values arrange themselves along a straight line, intersecting the abscissa at a certain distance from the origin (Fig. 1). The values for the cation absorption are more irregularly scattered. The theory implies the existence of two separate respiration processes in the plant cells, 'ground respiration', which is not directly related to the uptake of salts, and 'anion respiration', the intensity of which is related to the quantity of salts accumulated during a definite time.

Anion respiration being much more sensitive to hydrogen cyanide than ground respiration suggests the idea of the active iron in the cytochrome-cytochromeoxidase system in some way promoting the transport of anions.

The change of valency of the iron atoms in a series of hæmin molecules is thought to effect the transport of anions according to the following scheme (see also Fig. 2):

$$\begin{pmatrix}Fe^{+++}\\3A^-\end{pmatrix} \overset{+\varepsilon}{\underset{-\varepsilon}{\rightleftarrows}} \begin{pmatrix}Fe^{++}\\2A^-\end{pmatrix} + A^-.$$

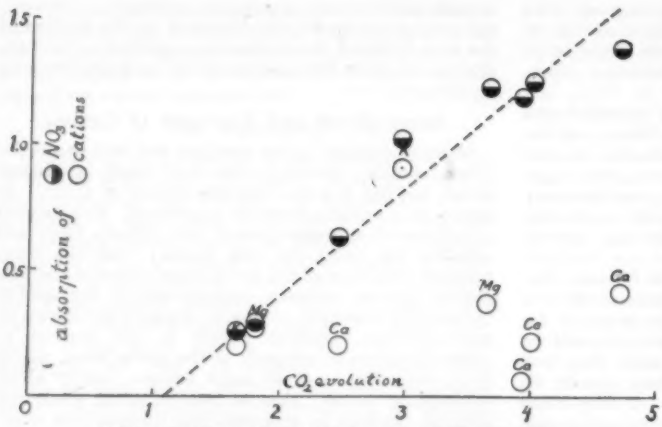

Fig. 1. The relation between respiration and absorption of nitrate and cations from solutions of single salts. From Lundegardh and Burström, *l.c.* 1933 (experiments with wheat roots).

The trivalent iron atom attracts one more anion than the bivalent iron atom. If the enzyme constitutes a structural unit, in which electrons move from one atom to another in the next molecule[7], the conditions necessary for transport of anions are fulfilled. If the molecules are arranged in such a way that they serve as a boundary between two media of different redox potentials, owing to the wave-like oscillation of the iron valency they will transport anions from a medium of higher oxidation power (Fe^{+++}, ox. side) to the medium of lower oxidation power (Fe^{++}, red. side). In general, the living cell or tissue will show the tendency to transport anions in the direction from the outside to the inside or from the surface to the interior.

The work involved consumes only a small fraction of the total energy transformation in the enzyme system, but the intensity of the oxidation must, on the other hand, be regulated by the concentration and the mobility of the accessible anions. This conclusion is in accord with the observation of a certain mass relation (k) between the anion respiration and the quantity of transported anions, and with the fact that k varies with the concentration and the general mobility of the ions.

An active accumulation of anions produces potentials which attract cations. The adsorbed metallic cations are liberated (exchanged for H-ions) at the points or surfaces of anion accumulation (Fig. 2). New cations are absorbed from the medium and transported owing to their concentration and mobility. The anion respiration thus acts as the promoter of salt accumulation even if the cations are more passively dragged through the protoplasm. This close interaction of anions and cations explains the unsuccessful attempts of some authors to distinguish between 'salt respiration' and 'anion respiration'. Apart from this distinction, the chief experimental results have been corroborated by the work of other laboratories[8]. The frequently observed fact that only growing cells are performing a more intensive accumulation work does not mean a direct linkage between salt accumulation and some synthetic process, for example, protein formation, but the energy production of the anion respiration system might, of course, frequently be utilized by such processes.

Owing to its higher electrical charge, the plasma membrane of growing cells is probably well adapted for an intensive absorption of cations, a circumstance which indirectly promotes also the absorption of anions.

Sap Movement and Bleeding

The existence of an exchange of ions between the medium and the plasma membrane gives the impression of a 'passive permeability' of the protoplasm to inorganic salts. During inhibited anion respiration under anaerobic conditions the cells lose salts, primarily cations. The salt store of a living cell is to be regarded as the result of a dynamic equilibrium between passive leakage and anion respiration. At high oxygen pressure accumulation predominates, at low oxygen pressure passive exudation. The centripetal transport of salts in the root proceeds in direction against the minimum oxygen pressure in the central parenchyma, from which the salts are passively exuded in the vessels. Water is osmotically moved in the same direction. The ascending sap stream appears as 'bleeding' if the plant is decapitated.

The osmotic fundamentals of bleeding are illustrated in Fig. 3. A U-tube is divided into two parts by means of a semi-permeable membrane m. The left limb contains pure water, the right limb, representing an osmotic cell, is filled with a solution, the

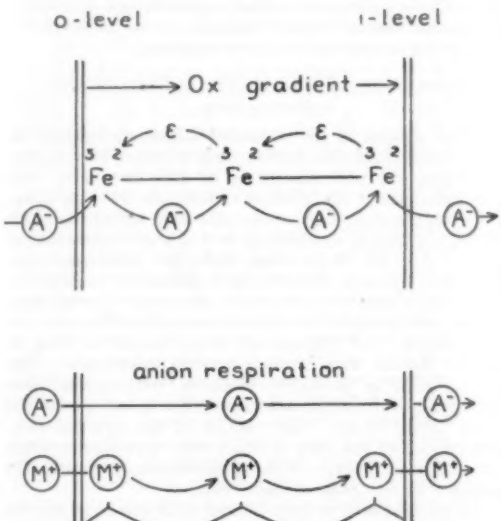

Fig. 2. Scheme of the theory of active absorption and transport of salts in a cell or a tissue. The salts are transported between the *o*-level (low concentration) and the *i*-level (higher concentration).

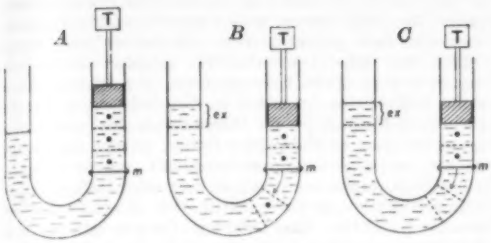

Fig. 3. SCHEME OF THE OSMOTIC FUNDAMENTALS OF BLEEDING.

concentration of which is symbolized by three black points, surrounded by three equal divisions of the water pillar. Equilibrium prevails between the osmotic pressure of the cell and the pressure of the weight T, symbolizing the turgor (Fig. 3, *A*). If one unit of osmotical substance is exuded, a corresponding volume of water must also leave the cell, if T remains constant. The rise in the left limb (*B*) represents bleeding. If one unit of osmotic substance disappears owing to metabolic processes, a corresponding volume of pure water is exuded (*C*). This 'extra water' in the bleeding sap can be experimentally induced by feeding the roots with sugar (transformation of glucose and nitrate to osmotically inactive protein). Also the swelling of the protoplasm under the influence of different ions takes part in the exudation of extra water.

The hydrostatic force by which the sap leaves the cells is equal to the turgor pressure (Fig. 3), a fact which explains the high pressures observed in a closed manometer. The concentration of the sap, and the bleeding force, can be experimentally increased by feeding the roots with easily transported ions, for example, K^+ and NO_3^-, whereas the slow-moving Ca^{++} gives a more diluted sap and lower pressure. Minimum pressures were observed after prolonged treatment with distilled water or solutions of sugar.

The chief promoter of the bleeding is the anion respiration, which transports salts from the medium to the vessels. The volume of water transported with each ion is inversely related to the osmotic pressure of the cells. The complete process is illustrated by Fig. 4. The osmotically attracted water is symbolized by a sphere of water around the ions. Molecules of sugar carry some water from the leaves, and water deriving from the medium is transported by carbon dioxide or other osmotic particles developed in the metabolism. Ions and carbon dioxide, exuded in the vessels, carry with them water 'envelopes' from the central parenchyma cells, together with quantities of 'extra water', which are liberated owing to metabolic processes (respiration) or changes in the swelling power of the protoplasm. Ions of high transport velocity predominate in the sap, for example, potassium and nitrate. The sap of wheat does not hold organic substances. Bicarbonates are present only under conditions which retard the transport of salt anions.

If an osmotic suction is applied from the medium, an outward-going stream of water competes with the inward-going sap stream. The observed bleeding obeys the formula $B = k\ (\sqrt{P_i} - \sqrt{P_o})$, P_i representing the bleeding force and P_o the osmotic value of the medium. In contradiction to earlier ideas of Atkins, Sabinin[9], *et al.*, P_i is not identical with the osmotic value of the exuded sap. Owing to exuded 'extra water' the sap is frequently more diluted than the medium at high P_o-values. The formula enables a convenient determination of the bleeding force. P_i varies within wide limits owing to varying supply of ions, sugar, etc., to the exuding cells, a circumstance which explains seemingly contradictory observations of earlier authors. Minimum values of $P_i = 0{\cdot}7$ atm. were observed in media free from salts. Feeding of the roots with rapidly absorbed potassium nitrate raises P_i to 5–6 atm.

The exudation of ions into the central vessels in itself is an anaerobic process, hence the bleeding does not stop immediately at oxygen deficiency. Anaerobic conditions, on the other hand, inhibit the anion respiration and the transport of salts to the stele. This is the reason why the bleeding stops a few hours after the exclusion of oxygen.

The high hydrostatic force developed in the absorption zone of the roots is a guarantee for the supplying of the aerial parts of the plant with nutrient salts. Guttation from leaves during inhibited transpiration is the visible sign of the high internal pressure. Transpiration accelerates the movement of the sap and augments the quantity of water transported. But the quantities of nutrient salts passively sucked through the living root tissue are very limited in comparison to the active accumulation due to respiration.

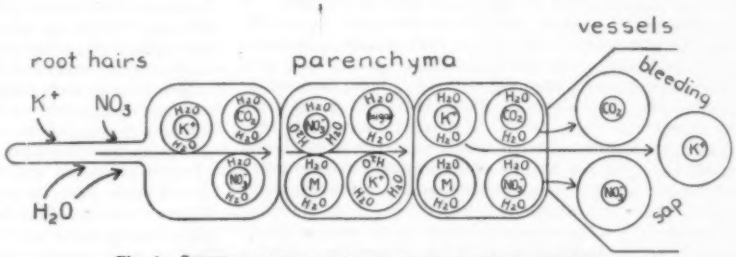

Fig. 4. SCHEME OF THE COMPLETE PROCESS OF UPTAKE, TRANSPORT AND EXUDATION OF SALTS AND WATER IN ROOTS.

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[8] van Eijk, M., *Rec. Trav. Bot. Néerl.*, **36**, 561 (1939). Robertson, R. N., *Aust. J. Exp. Biol. Med. Sci.*, **19**, 265 (1941); **22**, 237 (1944); **23**, 63 (1945). Hoagland, D. R., and Broyer, T. C., *J. Gen. Phys.*, **25**, 865 (1942). Machlis, L., *Amer. J. Bot.*, **31**, 183 (1944). Pepkowitz, L. P., and Shive, J. W., *Soil Sci.*, **57**, 143 (1944).

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NEWS and VIEWS

International Conference on Overfishing

One of the main achievements of fishery research in Great Britain and other countries has been to demonstrate that unrestricted fishing defeats its own end and leads inevitably to a diminution of total catch. This state of overfishing was shown to exist before the War in the North Sea and many other fishing regions. Realizing the danger of a recurrence of overfishing after the War, the British Government as early as 1940 appointed an expert committee to study measures for preventing it, and the recommendations of this committee, which included a proposal to limit the total tonnage of the fishing fleets engaged in any form of bottom fishing, were very carefully considered in all their aspects, in consultation with the trawling industry. As a result, His Majesty's Government considered it opportune to convene a conference of the twelve nations principally concerned, to discuss the possibility of international action to combat overfishing in the North Sea and other waters adjacent to the British Isles. The Conference met in London during March 25–April 5, and its conclusions are embodied in the "Final Act and Convention of the International Overfishing Conference" (Cmd. 6791; H.M. Stationery Office. 2*d*. net).

The Convention formally signed at the Conference, with a view to subsequent ratification, provides for a moderate increase in the size of mesh to be used and in the size-limits for the main species of fish; it represents therefore a definite advance upon the similar Convention signed in 1937 which was never fully enforced. On the more important question of limiting fishing power to an economic level, agreement could not be reached, though most delegations accepted the view of the British Government that mesh regulations and size-limits were not enough and must be supplemented by some form of direct control of fishing power. The Conference did, however, make the important recommendation that a standing advisory committee should be set up at once to study the question further, and make proposals within a year as to the best form of regulation to prevent overfishing. It also recommended that, pending the report of this committee, the Governments concerned should endeavour to prevent any undue growth in the size of their fishing fleets, though several countries made reservations on this point. The Conference was undoubtedly a useful one, and provided a welcome opportunity for an exchange of somewhat divergent views. Though it did not achieve complete success from the British point of view and that of several other nations, it at least left the question of overfishing open for further and urgent consideration.

National Parks in Britain

Sir Norman Birkett recently delivered the Rede Lecture at Cambridge and chose for his subject "National Parks and the Countryside" (London: Camb. Univ. Press. 1*s*. 6*d*. net). During the course of the lecture, a strong appeal was made that steps should be taken immediately to establish national parks in Britain. Of course, nothing on the scale of the Canadian or American parks is possible, but it is suggested that areas as small as 200 acres—though not smaller—would be adequate. The word 'park' is unfortunate as it has an urban connotation for most people. What is envisaged are large districts of wild and cultivated land in beautiful regions where moor and fell, stream and crag can eternally teach man the true values in life. Doubtless such tracts where the jaded town dwellers might roam at will would not be difficult to acquire; surely one of the main difficulties inherent in the scheme is in the nature of English people themselves. National parks must be open to the public freely, except such areas as are actually under cultivation; will it ever be possible to train users not to turn any park in a few years into a vast litter bin? Sir Norman Birkett seems to think that untidy people are only a minority; unfortunately, rubbish such as broken bottles, etc., does not disappear. At the same time as the parks are created, the Ministry of Education should be asked to start a nation-wide drive to inculcate the necessity of tidiness; then the next generation may be different in this respect.

Science and the Social Order

The object of the pamphlets in the Series "Looking Forward", issued by the Royal Institute of International Affairs, is to present problems rather than to solve them; and Dr. C. H. Desch has carried out this purpose in his "Science and the Social Order" (pp. 49. 1*s*. net). For the man of science, the pamphlet is indeed too elementary to be of much interest: its value lies rather as a means of educating the general public on the importance of the scientific habit of mind, as distinct from the knowledge acquired by scientific methods, and the dependence of government and administration on information supplied by scientific experts. Dr. Desch presents lucidly but persuasively the case for the use of scientific methods in planning—for substituting factual knowledge for guess-work—and emphasizes that only planned direction on an international scale making use of all the resources of science, physical, chemical, biological and sociological, is capable of undertaking the immense task of reconstruction that confronts us. He steers clear of political issues while stressing the need for further development of the social sciences, and he does not fail to challenge scientific men themselves to recognize their exceptional position and to determine that, so far as in them lies, their work will be directed to social uses. Dr. Desch suggests that as sociology becomes more generally accepted as one of the sciences, and as the history of scientific discovery is more and more studied in relation to political and economic history, appreciation will grow of the fundamental importance of science in the modern community. Within limits the physicist, chemist or biologist will become something of a sociologist, and the linking of his efforts in his special science with the service of society may resolve the ethical dilemma. Dr. Desch insists further on the need for clear exposition and the avoidance of jargon, and also on the impossibility of limiting scientific research and particularly fundamental research.

Continuity and Discontinuity

Prof. J. K. Robertson, professor of physics, Queen's University, Kingston, Ontario, in his presidential address to the Royal Society of Canada delivered on May 21, 1945, argues that the notions of continuity and discontinuity as used in physics and other sciences are complementary and not just contradictory. When, in the eighteenth century, physical theory was occupied with the continuous aspect of things it was natural to suppose that the structure of the world must be either continuous or discontinuous,

not both. Therefore, since continuity was apparent, there could be no discontinuity anywhere, as Leibniz argued. The chemical atomic theory and the kinetic theory of gases of the nineteenth century brought out the aspect of discontinuity for the first time, and recent sub-atomic physics has gone a stage further. At every stage, however, as Prof. Robertson emphasizes, theory really requires both continuity and discontinuity. This was first realized in the case of light, which in some aspects is continuous, and in others discontinuous; and, later, electrons were found to play a similar dual part. Granted that the single electron is discrete, indefinite and indeterminate, it should not be inferred that the continuity, definiteness and strict causality found in the behaviour of large numbers of electrons are not equally genuine aspects of the physical world. Prof. Robertson refers briefly to the way in which the biological theory of evolution requires both a continuous long-term aspect and a discontinuous short-term one; and he ends by asking the question, whether new discoveries in science which look like discontinuities in the historical development of thought are not also in other respects examples of the continuity of thought.

Personnel of Museums

Dr. Allan's presidential address to the Museums Association on July 5 last is published in the *Museums Journal* (August 1945, pp. 73–80) under the title of "Museums Manpower". Dealing with the qualifications to be looked for in candidates for administrative posts in museums, Dr. Allan emphasizes (1) the educational background (which is usually provided by a university course leading to a degree or diploma); (2) specialized training in the museum; (3) ability for the work entailed; and (4) personality (which is not least in importance). That these attributes are not always recognized as essentials to good curatorship is evidenced by the numbers of small, dismal and neglected museums that are still to be found in various parts of Great Britain, and also by Dr. Allan's subsequent reference to the common contention that few museums can afford to employ holders of degrees or diplomas. In criticizing that attitude, he rightly points out that a local authority or public body which undertakes the provision of a public service (museum or otherwise) also undertakes the responsibility of maintaining it in efficiency. Referring specifically to local museums, he says: "If the local museum is merely a repository of curios, a caretaker is clearly all that is needed. . . . If the museum is to be an educational instrument . . . then it must be equipped and staffed accordingly—and the bill will be correspondingly higher."

Contrasting local museums in Britain with those of pre-war Europe, for example, Dr. Allan says, "much of our museum presentation is ill-founded and amateurish", and again, "a wonderful story available in museum material is all too often badly mishandled". There are, of course, notable exceptions, and Dr. Allan, recognizing the progress that has been made in several quarters, is not pessimistic as to future developments. Of museum committees Dr. Allan speaks with caution, but he shows clearly that only co-operation and a measure of understanding between those bodies (which he terms 'non-museum expert') and the museum official (the 'museum expert') will make for the fruition of the task common to both, namely, the production of an efficient service. A study of Dr. Allan's address in full should be not only of value to those already in the profession and those serving on museum committees, but to those, also, who aspire to a museum career.

Federation of Documentary Film Units

The Federation of Documentary Film Units, which was set up in the middle of 1945 as a consultant and information organisation representing eight of the leading independent units making documentary and educational films, is issuing a regular *Bulletin* which will deal in turn with the use of films in health and medicine, industry, education, food and agriculture, architecture and housing. The periodical will attempt to report progress in providing films to meet specific needs in these fields, and will record work being carried out by professional and research institutions in assessing available films and will outline films made or in production. The first to be issued, dated January 1946, attempts to give some of the background information, outlining the system of sponsorship under which the making of documentary films has been carried out from the start. The Federation is organised to survey the requirements of potential sponsors, to advise on subjects, indicate production facilities and costs, and channels of distribution available. Inquiries relating to the making and showing of all types of factual films will be welcomed and should be addressed to the Organising Secretary, 18 Soho Square, London, W.1.

Survey of India

The Civil Activities Report for the War Period, 1939 to March 31, 1945, of Survey of India, now published by order of the Surveyor-General, is in two parts. The first, dealing with activities up to March 31, 1944, indicates that the re-survey of India scheduled for completion in twenty-five years and 25 per cent incomplete in 1939, has been in abeyance since 1940–41, when 2,400 square miles were surveyed as against 8,500 in 1939–40 and 20,000 in 1938–39. Geodetic and other scientific survey activities were mainly shelved, except those such as tidal operations and certain computations which had a direct bearing on the war effort or were essential to the welfare of the country. Scientific work was also suspended early in the War, except such as was required for war purposes, but on the outbreak of war with Japan the War Survey Research Institute was created, which has carried out valuable work for the Armed Forces, much of which will be useful in reconstruction and development after the War. Big strides have been made in the design of instruments and the application of methods expediting and cheapening precision survey technique.

Further reference is made in the second part of the report, covering the year April 1, 1944, to March 31, 1945, to the improvement of air survey methods to meet requirements with the minimum use of skilled personnel, and some of the methods used for the air photo mosaic and for the large-scale mapping of dam sites for engineering plans are described by Lieut.-Colonel D. R. Crane in an appended note. The War Survey Research Institute, during this period, in addition to providing tidal data at many ports, carried out much research on the improvement of base measurement apparatus so as to take advantage of the much improved precision of modern angle-measuring instruments and new technique. It is also proposed to lay out over India a highly accurate framework, the All India Development Survey Frame-

work, consisting of distinctive permanent marks at suitable intervals and engraved with precise position, height and other relevant data to serve as a local starting point for surveys of all kinds.

Agricultural Policy in Jamaica

THE report of the Agricultural Policy Committee of Jamaica appointed in May 1944 has now been published (Kingston, Jamaica : Dept. of Agriculture. 1*s.*). The terms of reference were wide, including the definition of a policy for the utilization of land resources, a policy for agricultural development, proposals for co-operation between producers and the Government, and the co-ordination of all Government services concerned with rural development. Jamaica is entirely dependent on the land for sustenance, and there are no manufactures based on imports of raw material. The total available land is inadequate for the needs of the present population, quite apart from the fact that much of the land has been misused and that the capital essential for large-scale rehabilitation is lacking. In its report, the Committee shows the urgency of the situation and puts forward a number of specific proposals to remedy it. Among the recommendations made is the establishment of a land authority for the purpose of bringing all land into proper use, and the suggestion that relief employment should be directed into productive channels, such as improvement in water supplies, soil conservation or afforestation. Emphasis is also laid on the need for progressive policies on questions of housing and education. As regards economics, colonial preference and long-term guarantees as to markets and prices are considered essential for the future prosperity of Jamaica, while to promote a general increase in efficiency, practical proposals are brought forward for improving organisation and co-ordination of Government departments.

Field Tests of Paludrine

SOME preliminary results of the effects of paludrine, the new synthetic antimalarial drug (see *Nature*, 156, 596 ; 1945 ; and 157, 128 ; 1946), are reported in the *Lancet* (Feb. 23, p. 278). Brigadier Hamilton Fairley and his colleagues in Australia have fully confirmed the results of studies made in England, and their work indicates that small daily doses of paludrine effectively suppress both benign tertian and malignant tertian malaria. Benign tertian malaria, however, developed in some subjects who were receiving daily doses of paludrine for three weeks after the last bites of the infected mosquitoes. A single dose of paludrine given weekly for an indefinite time after the primary attack of malaria has been controlled will prevent relapses of benign tertian malaria until it is eradicated. The fact that paludrine is an effective clinical cure of attacks of benign tertian, malignant tertian and quartan malaria was also confirmed. Paludrine did not, however, prevent the production of gametocytes of either *Plasmodium vivax* (benign tertian malaria) or *P. falciparum* (malignant tertian malaria), the structure and number of which were not materially altered by it. Nevertheless, the gametocytes did not mature when they were taken in by mosquitoes from subjects who were receiving paludrine, although, a week after the drug was discontinued, the gametocytes could infect mosquitoes. In addition to this, when mosquitoes were allowed to feed on a subject who was taking paludrine and then were allowed to complete their meal upon a subject who was harbouring gametocytes but was not taking paludrine, the mosquitoes did not become infected. This suggests, the *Lancet* says, that paludrine acts upon the early stages of development of the malarial parasites in the mosquito. This action on the developmental stages in the mosquito did not occur when the mosquito had been infected some days before the meal of blood taken from the subject who was receiving paludrine. One interesting result obtained was the observation that 200 c.c. of blood taken from subjects known to be infected with benign tertian malaria did not infect volunteers while the donors were taking paludrine. Quinine and mepacrine will not prevent infection in similar circumstances. A re-examination of the toxicity of paludrine has shown that, within the wide range of effective dosage, its toxicity is negligible. The volunteers from the Australian Forces who allowed themselves to be experimentally infected and so made possible the work at the Australian Army Medical Research Institute at Cairns, Queensland, deserve our deepest gratitude.

Medical Use of Sulphonamides

THE second edition of the Medical Research Council's War Memorandum No. 10, entitled "The Medical Use of Sulphonamides" (H.M. Stationery Office, 1945. 1*s.* 3*d.* net), by various authors and edited by F. Hawking and F. H. K. Green, incorporates the advances made since the first edition was published in 1943 in our knowledge of the uses of sulphonamides, and includes sections on the use of three of the many sulphonamides which have been introduced since the first edition of the memorandum was printed. These are sulphamerazine, phthalylsulphathiazole (also called sulfathalidine ; see also *Lancet*, 544, April 22, 1944) and marfanil (also called sulphabenzamine, which was used extensively by the German army and is now being manufactured by R. F. Reed, Ltd., Barking, Essex ; see also *Nature*, 153, 707 ; 1944 and 154, 795 ; 1944). Reference to a few additional members of the sulphonamide group of drugs is made under the headings of the infections for which they have been recommended. A section dealing with the relationships between penicillin and sulphonamide treatment is a useful addition to the memorandum. The spheres of action of these two forms of treatment overlap, and the notes given in this memorandum indicate the conditions which should be treated with sulphonamides and those for which penicillin, if it is available, should be used. The authors of the memorandum think that, when more penicillin can be obtained, it will replace sulphonamide more frequently, because it is usually more effective against infections which are also susceptible to sulphonamides. The memorandum states, for example, that penicillin has revolutionized the treatment of gonorrhœa, so that the instructions given for the sulphonamide treatment of this infection apply only when penicillin cannot be obtained or when the response to it has been unfavourable. A valuable minor feature of the memorandum is its list of the synonyms of the various sulphonamides.

A Star Atlas for 20°–40° N.

A STAR atlas, which has now run into the fourth edition, has been prepared by Dr. H. E. Hurst, M. R. Madwar and A. H. Samaha, and published by R. Schindler, Cairo. It contains six maps which enable readers to identify the stars visible in Egypt, North

Africa, southern United States, China, northern India and the Middle East. Each map represents the sky at the same time of the night with intervals of two months, or, what amounts to the same thing, the sky on the same day with intervals of four hours. Full explanations are given for using these charts which, though constructed for latitude 30° N., can be used also with sufficient accuracy for latitudes varying between 20° N. and 40° N. The local mean time of Cairo is used throughout, but the necessary correction for any other longitude can be easily made.

There is much useful information on other matters, such as a table of the constellations in which the planets appear, a list of the brightest stars, hints for identifying the stars, etc. One error should be corrected in the next edition. On p. 44 it is stated that the equation of time is the amount to be added to apparent solar time to give mean solar time, and the equation of time is given for the various months. The wrong signs are given in all cases and the equation of time, as given in the *Nautical Almanac* since 1931, is apparent time minus mean time. The method of reckoning the equation of time as given in the "Star Atlas" is that in use prior to 1931.

British Bryological Society

A MEETING of the British Bryological Society was held at Appleby, Westmorland, during April 10–17, under the presidency of Mr. W. R. Sherrin. Thirty-two members attended. Excursions were made to Cross Fell, High Cup Nick, Sunbiggin Tarn and other places in the neighbourhood. Among the many interesting bryophytes seen was the moss *Schistostega pennata*, which has not previously been found in Westmorland. During the meeting it was decided to enlarge and improve the Society's annual report and to embark on a scheme of co-operative observations on the season of production of sexual organs and sporogonia in various common bryophytes. It is hoped later to extend the scheme to other aspects of the biology of bryophytes.

Bee-keeping

BULLETIN NO. 9, entitled "Bee-keeping" (London: H.M. Stationery Office. 9*d*. net), issued by the Ministry of Agriculture and Fisheries, has been entirely rewritten; the present issue is therefore a new publication that takes the place of its predecessor. Dr. C. G. Butler, apicultural expert on the staff of the Rothamsted Experimental Station, has been responsible for this booklet. It is intended as a short introduction to bee-keeping and is specially adapted for beginners, who will find a great deal of useful information compressed within its twenty-seven pages. It does not, however, take into account bee diseases and some other aspects of bee-keeping, which are being dealt with elsewhere.

Atomes: A French Popular Journal of Science

THE re-awakening of scientific studies in France—or rather their emergence from the 'underground' where they were maintained with much difficulty and hazard during the German occupation—has been marked by the reappearance of well-known scientific journals. To these must now be added *Atomes*, an illustrated review published on the first of each month from 37 rue Caumartin, Paris IX^{e} (30 francs; 300 francs a year). The purpose of the new journal as set out in an editorial note in the first issue (March) is to present to readers authoritative surveys of new scientific and industrial developments throughout the world. Most of the articles, it is hoped, will be written by distinguished French or foreign scientific workers, thus ensuring the accuracy so necessary for a journal of an educational character. The editor also intends that the journal shall be well illustrated. The first issue has articles by Prof. F. Joliot-Curie, Sir Robert Watson-Watt, Prof. S. Vavilov, Sir Howard Florey, with notes on current research and reviews of scientific books, and does not disdain to include some humour. Certainly, the promise of authoritative articles is well redeemed. The second issue includes among its contributors L. de Broglie, Prof. L. Binet and the head of the French television service. There are notes in both issues of French men of science who fell victims to the Germans. *Atomes* has made a good beginning; it is well illustrated and has an attractive coloured cover. The definition offered of a 'good article'—that it is one which informs the most learned and is understood by the layman—should lead to the best type of popularization. The new journal should play a very useful part in educating French readers in the developments and responsibilities of a scientific age.

Assistant Agricultural Attaché in Washington

MR. P. J. MACFARLAN, deputy executive officer of the Northamptonshire War Agricultural Executive Committee, has been appointed assistant to the Agricultural Attaché to the British Embassy, Washington. Mr. Macfarlan was educated at Edinburgh Academy and the University of Glasgow. He continued his agricultural studies at the West of Scotland Agricultural College and the Dairy School for Scotland and was, in 1937, awarded a Ministry of Agriculture postgraduate scholarship. He became vice-principal of the Chadacre Agricultural Institute in 1938, which post he held until the Institute was closed in 1940. Since then, he has been with the Northants War Agricultural Executive Committee, being appointed deputy executive officer in 1942.

Announcements

PROF. J. B. S. HALDANE, Weldon professor of biometry in the University of London, has been awarded the degree of doctor of science *honoris causa* by the University of Groningen. The degree will be presented at the opening ceremony of the new university year on September 16.

WE are asked to state that Höber's "Physical Chemistry of Cells and Tissues", reviewed in *Nature* of February 2, p. 116, is published in the British Empire by Messrs. J. and A. Churchill, Ltd., 104 Gloucester Place, W.1.

OUR attention has been directed to a communication in *Current Science* (July 1940, p. 333) on the existence of an epiphysis in the pisiform bone of the young Old World langur (*Semnopithecus entellus*) by Prof. A. A. Ayer, of the Department of Anatomy, Andhra Medical College, Vizagapatam. Prof. Ayer describes the insertion of the flexor carpi ulnaris tendon into the epiphysis of the pisiform, and compares this with the insertion of the gastrocnemius into the epiphysis of the os calcis. This observation is of particular interest as it antedates the recent correspondence by Harris, Hughes, Haines and Eckstein in *Nature* (153, 715; 154, 182; 1944).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Elastic Constants of Diamond

In 1914 I published a paper[1] on the lattice theory of diamond in which I obtained expressions for the elastic constants of this crystal in terms of two atomic force constants, one corresponding to the valency bond between next neighbour atoms, the other to the tetrahedral angle between the directions of these valencies.

As there are three elastic constants, C_{11}, C_{12}, C_{44}, this theory leads to an identity between them, namely,

$$\frac{4c_{11}(c_{11}-c_{44})}{(c_{11}+c_{12})^2} = 1. \quad . \quad . \quad . \quad . \quad (1)$$

At that time, no measurements of the elastic constants were available; apart from the compressibility, the characteristic temperature Θ of Debye was known, which is a complicated function of the atomic constants, but turned out to be useless for a reliable determination of them.

Lately, Prof. S. Bhagavantam and collaborators have developed a new method for measuring elastic constants of crystals[2] and have applied it successfully to many crystals. Their results for diamond are:

$$c_{11} = 9{\cdot}5 \times 10^{12} : c_{12} = 3{\cdot}9 \times 10^{12} : c_{44} = 4{\cdot}3 \times 10^{12} \text{ dynes/sq. cm.} \quad (2)$$

If these numbers are substituted into the identity (1), one finds for the expression on the left-hand side the value 1·10 instead of 1·00. The agreement seems fair enough to be considered a confirmation of the theory developed thirty-two years ago.

Yet there is a discrepancy of about 10 per cent, and the question arises whether this can be improved by taking into account the second neighbours of each atom. The theory was extended in that direction by N. S. Nagendra Nath[3] in 1934, who introduced a third constant representing the action of the second neighbours, regarded as central force. My collaborator, Miss H. M. J. Smith, has reconsidered the whole theory from a general point of view which I have described in my report on "Crystal Dynamics and X-Ray Scattering"[4]. This method consists in constructing the 'dynamical matrix' for each neighbour of a given atom in the cell and reducing it to its simplest form by applying the symmetry operations of the lattice. The result contains two parameters α, β for the first neighbours, and three parameters λ, μ, ν for the second neighbours. As the total number of these parameters (five) is larger than the number of elastic constants (three) no relation between the latter can be expected. If, following Nagendra Nath, the action of the second neighbours is represented by central forces, one has $\lambda = 0$ and $\mu = \nu$, so that only three parameters remain, α, β, μ; there is still no identity between the elastic constants.

But optical investigations supply other data. The infra-red absorption spectrum and the Raman effect have been studied[5-9]. These spectra are highly complicated and their interpretation is controversial. But there is one outstanding feature of which only one explanation seems possible: the strongest Raman line $\nu_0 = 1{,}332$ cm.$^{-1}$ corresponds to the limiting vibration of the lattice where the two face-centred simple lattices oscillate against one another as rigid frames. The four constants c_{11}, c_{12}, c_{44}, ν_0, can be expressed in terms of the three parameters α, β, μ; therefore, one has one identity, namely,

$$\frac{8 \cdot \frac{m}{2a} \cdot 4\pi^2c^2\nu_0^2 \left(\frac{m}{2a} \cdot 4\pi^2c^2\nu_0^2 + 8c_{11} - 16c_{44}\right)}{\left(3 \cdot \frac{m}{2a} \cdot 4\pi^2c^2\nu_0^2 - 8c_{11} + 16c_{12}\right)^2} = 1, \quad . \quad . \quad . \quad . \quad (3)$$

where m is mass of carbon atom, and $2a$ is lattice constant. If here the experimental values (2) are inserted, one obtains for the left-hand side 1·4 instead of 1·0. The agreement is less satisfactory than that obtained with the simple formula (1) based on first neighbours only.

Bhagavantam has compared his measurements with Nagendra Nath's theory in a different way. He has used definite interpretations of some weaker Raman lines, following Raman's general theory of lattice vibrations, and determined the three force constants in terms of the frequencies of these lines. Calculating the elastic constants with these data, he obtains almost perfect agreement.

This result is deceptive. In the first place, Nagendra Nath's formulæ as used by Bhagavantam are not correct: he has neglected a term which, in fact, is not small. Secondly, Raman's theory of lattice vibrations is untenable, and the interpretation of the observed lines therefore arbitrary. The excellent agreement is therefore accidental. Our identity (3), on the other hand, is independent of the doubtful interpretation of the second-order Raman spectrum. The fact that it is not satisfied by Bhagavantam's measurement may be due either to experimental errors, or to the assumption that the forces of the second neighbours are central, or finally to neglecting the forces of more distant neighbours. I am inclined to prefer the first alternative; for a small change of c_{44}, namely, $c_{44} = 5{\cdot}0 \times 10^{12}$ instead of $c_{44} = 4{\cdot}3 \times 10^{12}$ dynes/cm.^{2}, puts the identity (3) right.

The question of the infra-red absorption and the secondary Raman spectrum is under investigation (by Miss Smith). We have obviously to do with a spectrum of the same kind as in rock-salt, an explanation of which we have recently given[7]; it is the superposition of numerous bands each corresponding to a combination of two of the frequency branches of the elastic spectrum. A careful study of this problem for diamond will throw light on the much disputed difference between the two types of diamonds found by Robertson, Fox and Martin[8].

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Feb. 25.

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[2] Bhagavantam, S., and Bhimasenachar, J., *Nature*, **154**, 546 (1944).
[3] Nagendra Nath, N. S., *Proc. Ind. Acad. Sci.*, **1**, 333 (1934).
[4] Born, M., "Reports on Progress in Physics", **9**, 29 (1942).
[5] Sutherland, G. B. B. M., and Willis, H. A., *Trans. Farad. Soc.*, **41**, 289 (1945).
[6] Krishnan, R. S., *Proc. Ind. Acad. Sci.*, **19**, 216 (1944).
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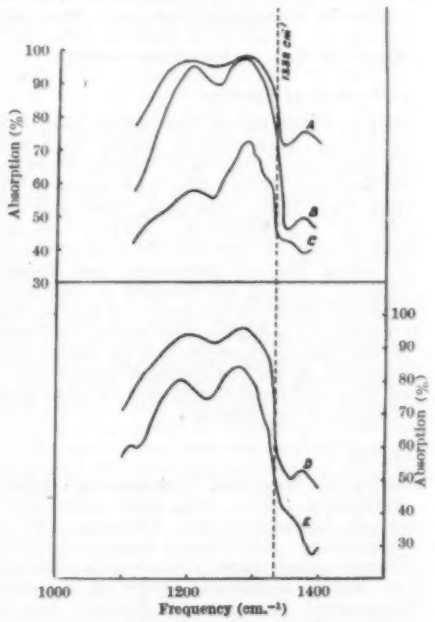
Infra-Red Absorption Spectrum of Diamond

In his comments appended to our note on the above subject appearing in *Nature* of January 12, Dr. Sutherland ascribes to us the statement that the "principal infra-red frequency of diamond has been defined as the position of minimum absorption". This is not what we said, neither does it represent the actual facts of the case. The true position is that pointed out by Sir C. V. Raman[8], namely, that in the 8 μ band of diamond, the infra-red absorption coefficient rises very steeply in passing through the fundamental vibration frequency of the lattice, namely, 1332 cm.$^{-1}$. The accompanying



absorption curves (*A*), (*B*), (*C*) and (*D*), carefully redrawn on a wave-number scale from the experimental results published by British observers[9-11], demonstrate that this is the actual situation. A similar feature appears also in the infra-red emission spectrum (Curve *E*) of diamond[9]. The 1332 cm.$^{-1}$ frequency is indicated by the vertical line which, it will be seen, in each case cuts through the curve at or near the point where it is steepest. There can be no doubt, therefore, that the absorption associated with that frequency is an integral part of the 8 μ band and that this latter has its primary origin in the infra-red activity of the fundamental lattice vibration. There remains no need for us to comment on the rest of Dr. Sutherland's note.

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Feb. 26.

[1] Sutherland, G. B. B. M., *Nature*, **157**, 45 (1946).
[2] Raman, C. V., *Proc. Ind. Acad. Sci.*, A, **19**, 189 (1944).
[3] Robertson, Fox and Martin, *Proc. Roy. Soc.*, A, **157**, 579 (1936).
[4] Sutherland and Willis, *Trans. Faraday Soc.*, **41**, 281 (1945).

The wording used by Krishnan and Ramanathan was "the centre of this fall (i.e. between the absorption maxima at 1285 and 1376 cm.$^{-1}$) coincides with the Raman frequency at 1332 cm.$^{-1}$". Not unnaturally I took this to mean the minimum of absorption between these two

peaks. Apparently what Krishnan and Ramanathan meant was the *centre of the side* of the band with peak at 1285 cm.$^{-1}$. But this is an equally untenable position. All the arguments in my earlier letter still hold if one replaces "minimum of absorption" by "centre of the long-wave side of the absorption maximum". Even their much milder statement in the above letter that "the absorption associated with the 1332 cm.$^{-1}$ frequency is an integral part of the 8 μ band" is open to question, as it depends on (*a*) the resolving power of the spectrometer used, and (*b*) the temperature at which the measurements are made.

It is quite possible that at very low temperatures these bands may sharpen so much that the 1332 cm.$^{-1}$ frequency cannot even be said to lie on the side of a band.

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March 29.

Topography of the Face of a Diamond Crystal

We have applied the multiple-beam interference technique described earlier[1] to the study of the topography of a natural octahedron face of a diamond, thus revealing considerable information about growth, etch, face curvature, etc. We have settled a fifty-year-old controversy concerning the origin of the beautifully regular shallow-pit triangular markings shown by such faces. Miers[2] cautiously stated that these are *supposed* to be due to etching and shows them pointing to the octahedron edge. Fersmann and Goldsmidt[3] asserted that etch or solution can be responsible both for the triangles and the curved faces. Williams[4] proposed on rather slender grounds that the triangular pits and curved faces arise from growth and not from solution.

We have now proved that a typical characteristic triangular pit is due to *growth*.

During the progress of the work, a novel interference method has been developed which will be described as a 'crossed fringe' technique. This simplifies and speeds up the analysis.

The optical flat is first set as near parallel as possible to the diamond face, giving maximum fringe dispersion and maximum sensitivity. All the visible mercury radiations are used, the result being the production of multiple-beam interference fringes which reveal in a striking manner much *sub-microscopic* topographical detail. It is not possible from such a picture to obtain much numerical information about the heights (depths) of features. However, an area of uniform tint means that such an area is of uniform height (depth) to within a very small fraction of a light wave. A change of only $\lambda/200$ can produce a tint alteration. The flat is then slightly tilted relative to the crystal, leading to the formation of sharp, widely spaced multiple-beam fringes[5]. These are photographed superposed on the high dispersion fringes.

The accompanying reproduction illustrates the technique, which permits of a rapid exact evaluation of the structure. The area represented is about 1 sq. mm. Attention is directed to the extreme fringe sharpness, AA' being successive orders for the green line of mercury, with the yellow doublet between.

Among other features, the reproduction shows a clearly marked triangle in the lower half. (Fringe displacement to the right here means an elevation.) The fringe from A continues unbroken until reaching the ridge XY at which it is displaced to the right. But the fringe *through* the triangle is quite clearly a linear continuation of A, hence the triangle base is at the same level as the large uniform area above XY. The depth of this particular triangle is only 440 A. Other triangles, of different depths, show the same effect. It is completely unreasonable to postulate a hypothetical etching that takes place down to the somewhat removed outside level. Nor can one suppose that simultaneous etch continues down to hypothetical abnormally resisting layers (at different levels for different features). This would be a highly improbable state of affairs indeed.

It is certain therefore that the area below XY has grown in the form of three plane waves inclined at 60° to each other. The arresting of such growth can lead to the formation of equilateral triangles (which may be and are occasionally truncated to hexagons). The triangle shown thus arises entirely through failure of the completion of the growth sheets, below XY, and etching has nothing to do with it. This particular triangle points to the octahedron edge.

A number of these triangular growth-pits have been measured, and depths ranging from some 60 to 600 A. found, that is, some 30–300 atom layers.

We have also found in addition distinct evidence of the existence of etching or solution, leading to the formation of irregular shallow hollows of arbitrary orientation. This will be discussed elsewhere.

Successive stepped growth-sheets are also clearly visible, and it is of considerable interest that these frequently grow in a stepped pyramid leading effectively to a curvature of the vicinal face, at times considerable. We believe that the well-known curvature of diamond faces and edges is also probably a *growth* effect.

We note that a previous attempt has been made to examine diamond topography by interference, but this[5] was effectively only a two-beam interference method and as such was completely inadequate for the purpose, showing only the coarsest of features and revealing little not already shown by the microscope.

A full report of the analysis of the mass of detail revealed by the precision multiple-beam 'crossed fringes' will be communicated elsewhere. Particular attention is directed to the very considerable saving in labour due to this technique.

We thank Mr. P. Grodzinski of the Diamond Trading Company for the loan of the diamond and for mounting it for us.

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March 7.

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[2] Miers, "Mineralogy" (1902).
[3] Fersmann and Goldsmidt, "The Diamond" (1911).
[4] Williams, "Genesis of the Diamond" (1932).
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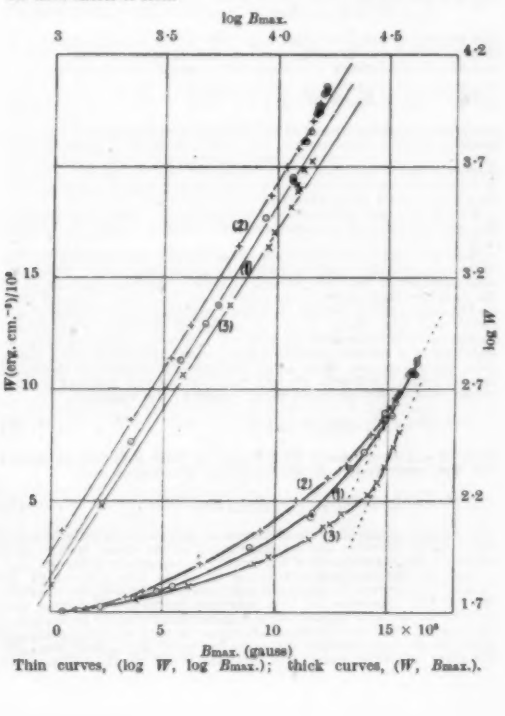
Loss Due to Magnetic Hysteresis in Silicon-Steel Sheets

We have determined magnetic hysteresis loops by the ring-ballistic method for three different sheets of silicon-steel in an extensive range of values of magnetic flux-density $B_{max.}$ ($B_{max.}$ is the flux-density corresponding to the cusp of the loop). From these loops we have derived the energy loss W, in ergs per cubic centimetre per cycle for different values of $B_{max.}$, and by plotting those values against the corresponding values of $B_{max.}$ we obtained the accompanying curves for three sheets of steel.



Thin curves, (log W, log $B_{max.}$); thick curves, (W, $B_{max.}$).

If Steinmetz's empirical law ($W = \eta(B_{max.})^k$ ($k \simeq 1{\cdot}6$) is applicable to our experimental data, then there must exist a linear relation between log W and log $B_{max.}$; we find such a linear variation, with the approximate error of 1 per cent, between the flux-densities of 1,000 and 12,000 gauss, with the following values for the constants η and k:

	Sheet 1	Sheet 2	Sheet 3
η	0·00076	0·0010	0·0011
k	1·66	1·65	1·59

It was found that Steinmetz's law is not applicable at high and low flux-densities. We have observed, like Brailsford[1], that for sheets 1 and 3, and very high values of $B_{max.}$, the hysteresis loss increases with $B_{max.}$ according to a linear law.

Moreover, it has been shown experimentally that, in accordance with theory, the influence of a superimposed steady unidirectional flux on the hysteresis loss is nil. The measurements were carried out with steel sheet 1 and for three different values of steady flux: 1,500, 4,100 and 11,300 gauss. 4,100 gauss is the value of the flux-density for which magnetic permeability of the material is a maximum. As an example, the experimental data for two loops of very different shape are: loop with steady flux = nil: $B_{max.} = 13{,}360$ gauss; $W = 6{\cdot}47 \times 10^3$ erg.cm.$^{-3}$; loop with steady flux = 11,300 gauss: $B_{max.} = 13{,}320$ gauss; $W = 6{\cdot}31 \times 10^3$ erg.cm.$^{-3}$.

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[1] Brailsford, F., *J. Inst. Elect. Eng.*, **90**, 313 (1943).

Biological Action of Radiations

IT has been shown previously[1] that when radiation (for example, X-rays, α-particles, neutrons) is absorbed in aqueous solutions, an indirect chemical effect is produced due to the formation of free radicals and atoms:

$$H_2O + \text{radiation} = H + OH \quad . \quad . \quad (1)$$

In general, this is followed by the recombination:

$$H + OH = H_2O \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

and by interactions of these radicals with other acceptor substances (S, S_1, S_2, . . .) present, for example:

$$S + OH = E_1 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

$$S_1 + OH = E_2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3{\cdot}1)$$

. . . . . .

$$S_{n-1} + OH = E_n \quad . \quad . \quad . \quad . \quad . \quad . \quad (3{\cdot}n)$$

This scheme of reactions must exist also in the aqueous systems of biological subjects. From the point of view of the older 'hit' theory[2], reaction (3) corresponds to a single 'hit', while if, for example,

$$E_1 = S_1\ ,\ E_2 = S_2\ ,\ \ldots\ E_{n-1} = S_{n-1} \quad . \quad . \quad (4)$$

one gets a successive change of the (starting) substrate (S) by $1,2 \ldots n$ interactions with, for example, OH radicals, which is equivalent to $1,2 \ldots n$ 'hits'. It can be shown that—under certain conditions—there is a complete formal analogy between the 'hit' theory, which is described by Poisson's formula, and the mathematical expression for the above system of equations (3, 3·1, . . . 3·n).

If the biologically active substance is represented by the molecule S, the *essential* interaction corresponds to equation 3 and the theory suggests two important cases:

Case A. The recombination process (2) can be neglected (if the interaction with the acceptor molecules is relatively fast). From the above scheme of reactions, it follows that in this case the action of the radiation (for example, the half 'lethal' dose $D_{1/2}$) depends only on the *total* number of ions (radicals) produced, independent of the nature and wave-length of the radiation. This case is represented, for example, by the mutations induced by X-rays. Under the assumption—which is almost certainly fulfilled—that apart from the S molecules there are also some other (biologically non-active) molecules present which react with the OH-radicals (thereby exerting a 'protection effect') the chemical theory leads to the equation:

$$S = S_0 \exp.\ (-\varkappa D) \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where S and S_0 represent the numbers of these molecules at times t and zero respectively; D, the total dose of radiation and:

$$\varkappa = \ln 2/D_{1/2} \sim q_e(q_{e_m}[S_m])^{-1} \quad . \quad . \quad . \quad (6)$$

where q_e represents the (kinetic) cross-section of the S molecules and the term in brackets can be interpreted as the mean linear region available per one molecule of the (protecting) substrate molecules (S_m).

Case B. Recombination reaction (2) taken into account (if the radicals are present in relatively high concentrations or, for example, the acceptor molecules are relatively non-reactive). It follows that in this case the *local* concentration and distribution of the radicals is of importance. While for different radiations the number of ions (radicals) produced is approximately the same for equal doses, their local distribution may differ widely. In this case, therefore, the action of the radiation must depend on the nature of the radiation, as is known to be the case, for example, of the lethal effect on unicellular organisms.

The above scheme leads to the following expression (with certain simplifying assumptions):

$$S = S_0 \exp.\left(-\frac{k_2 D}{k_3[H]_l}\right) = S_0 \exp.\ (-\alpha D) \quad (7)$$

where $[H]_l$ represents the *local* concentration of the radicals in the regions where the actual reaction takes place. As a first approximation $[H]_l$ can be estimated for two important stages of the reaction. (i) *In the initial stage*, that is, before any appreciable diffusion of the radicals (formed in the tracks of the ionizing particles) has set in. Here one may assume that:

$$[H]_{l(I)} \propto \text{number of ions per unit length of track} \quad . \quad . \quad (8)$$

This quantity is known experimentally[3,4] for different radiations. More generally, one has approximately[5,6] (if V denotes the energy of the radiation):

$$[H]_{l(I)} \propto V^{-1} \text{ (for X-rays)} \quad . \quad . \quad . \quad . \quad (9)$$

$$[H]_{l(I)} \propto V^{-1/2} \text{ (for } \alpha\text{-rays)} \quad . \quad . \quad . \quad (9a)$$

till) *In the advanced stage* (but before any appreciable intermixing of the individual ionization tracks has occurred):

$$[H]_{l(II)} \propto V \quad . \quad . \quad . \quad . \quad . \quad (10)$$

Taking into account both these stages for the action of, say, X-rays, one obtains for α of equation 7,

$$\alpha = \alpha_{(I)} + \alpha_{(II)} \propto \frac{k_2}{k_3}\,\frac{1}{V}\left(\frac{V^2}{a} + 1\right) \quad . \quad . \quad (11)$$

where a denotes a proportionality factor. Remembering that $V \propto \lambda^{-1}$ and that for the range (R_e) of the (ionizing) fast electrons one has the relation[5]: $R_e \propto V^2$, one obtains finally from equations 7 and 11

$$D_{1/2} = \ln 2/\alpha \propto \frac{1}{\lambda}\,\frac{a}{(R_e + a)}, \quad . \quad . \quad . \quad (12)$$

which is formally identical with Glocker's well-known expression.

It is now possible to predict that if sufficiently hard γ-rays or X-rays are used, the dependence on the wave-length should gradually diminish and finally disappear. This can be illustrated by Wykoff's own figures[8] for *Bacterium coli*, where the mean lethal dose decreases in the series of decreasing wave-length as: 8·4, 6·67, 4·65, $4{\cdot}20 \times 10^5$r, and in order to achieve the same effect with α-rays, 24×10^5r are required. On the other hand, while it is known that the doses of radiation for the production of mutations are independent of the wave-length in the case of γ- and X-rays[9] a much higher dose of neutrons is required to produce the same effect[10]. This follows directly from the above theory, as the recoil protons produce a relatively high local ion (radical) density leading to increased recombination.

A full account will be published elsewhere which will include also a discussion of 'multiple hit effects', where the situation is somewhat different[11].

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Jan. 25.

[1] Weiss, *Nature*, **153**, 748 (1944).
[2] cf. Mayneord, *Proc. Roy. Soc.*, **A**, **146**, 867 (1934).
[3] cf. Gray and Read, *Brit. J. Radiol.*, **15**, 72 (1942).
[4] Lea, *Proc. Camb. Phil. Soc.*, **30**, 80 (1934); *Brit. J. Radiol.*, **16**, 338 (1943).
[5] cf. Bethe and Bacher, *Rev. Mod. Phys.*, **8** (1936).
[6] Bagge, *Ann. Phys.*, **30**, 72 (1937).
[7] Glocker, *Z. Phys.*, **77**, 653 (1932).
[8] Wykoff, *J. Exp. Med.*, **51**, 921 (1930); **52**, 435, 769 (1930).
[9] cf. Schrödinger, "What is Life?" (Cambridge, 1944).
[10] Timoféeff-Ressovsky and Zimmer, *Naturwiss.*, **26**, 362 (1938).
[11] cf. Hevesy, *Rev. Mod. Phys.*, **17**, 102 (1945).

Effect of Container Walls on Packing Density of Particles

IN recent correspondence[1] in *Nature* a general theorem on the ordered packing of equal spheres is cited as implying that "the overall voidage of any one of the four possible ordered arrangements of equal spheres packed into a container is independent of the relative size of the container provided its size and shape are such that it will contain an integral number of 'unit' cells of the particular ordered arrangement and in all other cases an ordered packing cannot be obtained". This is due to a misconception of the 'unit' cell, which in the first three out of the four ordered packings, namely, a sphere having 12, 10, 8 or 6 neighbours, really contains fractions of a sphere totalling to one, and it is only in the fourth case that the unit cell, being a simple cube, contains a whole sphere.

Furthermore, the inescapable higher voidage adjacent to the container walls as compared to the interior of the container has to be taken into account[2], and its contribution to the overall voidage has to be allowed for; unless it happens to be negligible, as with a container of very large size compared to the particle size of the packed material. Characteristic voidage for a compacted packing of a sized material is then found to depend more on the particle shape[3-5] than on the particle size. This increases with increased deviation of the irregular particles from a spherical shape, unless conditions exist to

promote bridge formation, such as, for example, extremely fine particles or extremely loose packing[4].

If it is assumed that under given conditions of packing a specific ordered or disordered arrangement of particles of a sized material results, depending only on the method of packing and particle shape, then this arrangement may be taken to exist in the central regions of any container thus packed. Now supposing in a very large container assumed to be packed in this manner an imaginary plane is inserted, then this plane will cut through a given number of particles on the average. If this plane is now to be regarded as a constricting wall of a container, the number of particles cut through by the plane will have to be eliminated, and the extra voidage thus caused considered as that due to the container wall, provided it is assumed that the container walls have no influence on the detailed arrangement of packing; but only act as a limiting boundary of the general packing arrangement. It can then be shown that

$$d_n = \left(\frac{n-1}{n}\right)^3 . d_0 . \quad . \quad . \quad (1)$$

where d_n is the overall packing density in a cubic container having sides n times particle diameter of the sized material (say, $2nr$) and d_0 is the characteristic packing density of the material in the interior of the container, which may be regarded as specific to the material and the mode of packing; n will, of course, have to be sufficiently large to give a definite physical meaning to d_0.

Equation (1) would apply equally well to a cylindrical container the diameter and height of which are each equal to $2nr$. It may be further generalized to apply to right-cylinders of unequal dimensions or rectangular containers as follows:

$$d_n = \left(\frac{n_1-1}{n_1}\right)\left(\frac{n_2-1}{n_2}\right)\left(\frac{n_3-1}{n_3}\right) d_0, \quad . \quad (2)$$

where n_1, n_2 and n_3 represent the dimensions of the container in three orthogonal directions in terms of particle diameter.

Equations (1) and (2) may be further shown to hold for a material having more than one component size, in which each small-sized fraction is present in sufficient proportion to fill up the voidages produced by the next larger-sized fraction. In this case n's will be taken in terms of the smallest-sized fraction. For a similar reason, even in the case of sized material, n's may be taken more appropriately in terms of smaller-size particles.

Applying equation (1) to the data given by Brown and Hawksley[1] for packing two sizes of graded coal in a 10 in. cube container, we find that, if $d_0 = 0{\cdot}60$, the voidages are 0·48 and 0·42, as compared with the experimental values of 0·47 and 0·43 respectively.

Container walls, however, definitely influence the distribution of neighbouring particles and not merely interrupt this distribution as implied above. Assuming that this influence of the walls on the spatial distribution of particles is confined to the first layer of particles immediately next to the boundary, equation (1) may be modified as follows:

$$d_n = \left(\frac{n-1}{n}\right)^3 d_0 + \left[1 - \left(\frac{n-2}{n}\right)^3\right] \Delta d \quad . \quad . \quad (3)$$

where Δd represents the deviatıcn of packing density at the boundary layer from what it would have been had the walls been assumed to have no effect on the general distribution of particles, represented by a packing density d_0.

This equation, when applied to Brown and Hawksley's data cited above, gives $d_0 = 0{\cdot}58$ and $\Delta d = 0{\cdot}11$.

Sufficient experimental data are not available in the literature to establish finally the general applicability of these equations, but work dealing with experimental aspects is in progress.

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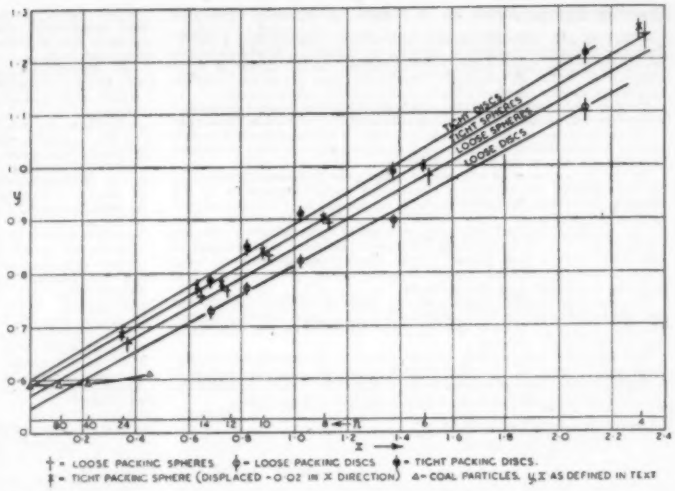
Dec. 20.

[1] Brown, R. L., and Hawksley, P. G. W., *Nature*, **156**, 421 (1945).
[2] Anderegg, F. O., *J. Ind. Eng. Chem.*, **23**, 1062 (1931).
[3] Fraser, H. J., *J. Geology (Chicago)*, **43**, 936 (1935).
[4] Wadell, H., *J. Geology (Chicago)*, **43**, 276 (1935).
[5] Furnas, C. G., *J. Ind. Eng. Chem.*, **23**, 1052 (1931).
[6] Meldau, R., and Stach, E., *J. Inst. Fuels*, **7**, 336 (1934).

Dr. Verman and Dr. Banerjee rightly direct attention to a point we overlooked in a previous communication[1] on containers which will fit the unit cells of regular packings of equal spheres. The spheres in the unit cell are sliced and can be reshuffled to give whole spheres in a given container only for a cubic packing. For the other three ordered arrangements a slight adjustment of the spacing of the walls is needed to accommodate the whole spheres.

In connexion with the equations proposed for assessing wall effect, confirmatory evidence may be cited from experiments we have done on the packing of spheres (¼ in. ball bearings) and of cylindrical disks (diameter ¼ in., height ¼ in.) in cubical metal containers 1–5 in. in size. The packing obtained by pouring the particles rapidly into the container is referred to as loose; that obtained on simultaneously shaking the container in a horizontal plane is referred to as a tight packing. The containers were overfilled and the surplus particles were swept off with a straight edge. There is some difficulty in defining the top surface in this way for the smaller containers, and the convention that no particle should project above the top of the container was adopted. Thus the inherent error varies as $(1/n)$, where n is the ratio of container to particle size. Ten repeat measurements were made for relative container dimensions of $n = 4$–24. The value of n for disks was found from the equivalent spherical diameter.


TIGHT DISCS
TIGHT SPHERES
LOOSE SPHERES
LOOSE DISCS
y
x
† = LOOSE PACKING SPHERES. ϕ = LOOSE PACKING DISCS. ϕ = TIGHT PACKING DISCS.
‡ = TIGHT PACKING SPHERE (DISPLACED −0·02 IN X DIRECTION). Δ = COAL PARTICLES. y, x AS DEFINED IN TEXT

Plotting the results in the form y against x' where

$$y = d_n\left(\frac{n}{n-1}\right)^3 ; \; x' = \left(\frac{n}{n-1}\right)^3 - \left(\frac{n-2}{n-1}\right)^3 \quad (A)$$

and for which equation 3 proposed by Dr. Verman and Dr. Banerjee suggests the linear relation

$$y = d_0 + x'\Delta d \quad . \quad . \quad . \quad (B)$$

proved to give a slight curve. This was thought to arise from the perturbing influence of the walls extending beyond the immediate adjacent layer of particles. On the other hand, substantial straight-line plots were obtained by plotting y against x where

$$x = \left(\frac{n}{n-1}\right)^3 - \left(\frac{n-3}{n-1}\right)^3 \quad . \quad . \quad (C)$$

This is shown in the accompanying graph, where the scatter of replicate measurements is plus or minus twice the standard deviation of the average.

It will be evident from the graph that a linear relation of the form of equation B is *statistically* valid for both loose and tight packings of equal spheres; in both cases Δd is approximately 0·25; d_0 is 0·57 for loose and 0·58 for tight packings. The data are not sufficient to show whether Δd is the same for loose and tight arrangements.

With non-spherical particles, the disks yield the same conclusion, with Δd approximately 0·28, $d_0 = 0{\cdot}60$ for tight and 0·54 for loose packings. It will be noted that the results for spheres lie between those for disks.

It may also be of interest to give the results for irregularly shaped coal particles sized 0 × ¼ in., ¼ in. × ½ in., ½ in. × ¾ in., ¾ in. × 1 in. sq. mesh ($n = \infty$, 80, 40, 20 respectively in a 10-in. cube). Here the accuracy suffices only to show that Δd is much smaller than with disks, while d_0 is 0·59. Further work is needed to test the validity of equation 3 with coal particles.

It would appear that d_0 (or the interior packing) within the range of our experiments has an *average* meaning down to $n = 4$, which corresponds to about sixty particles.

In conclusion, it may be noted that Mr. Leftwich's calculations[2] provide a good test of the equation proposed by Verman and Banerjee for the geometrical effect of walls around ordered packings of equal spheres. With slight discrepancies the calculations follow the equation

$$d_n = \left(\frac{n-\frac{1}{2}}{n}\right)^3 d_0 \quad . \quad . \quad . \quad . \quad (D)$$

with $d_0 = 0{\cdot}7405$. The modification of $(n-1)$ to $(n-\frac{1}{2})$ arises from the choice in the calculations of five planes tangent to a sphere layer (and therefore 'cutting' on one side only); equation D is valid for six such tangent planes, and the discrepancies presumably arise from a small unfilled region at the top of the box.

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[1] *Nature*, **156**, 421 (1945).
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Electron Bombardment as a Means of Material Transfer

HITHERTO, the two recognized methods for transferring material from one electrode to others in vacuum have been (1) heat treatment, (2) sputtering by positive ion bombardment. In the course of some work at the G.E.C. Laboratories, it appeared that it was also possible to achieve similar effects by the use of electron bombardment.

Targets of barium, strontium, cæsium and sodium were bombarded with electrons of varying energy, and the effects of the bombardment —the transferring of these materials to other electrodes in the vacuum —were demonstrated by the changes in thermionic emitting properties of a test cathode of strontium oxide.

In the normal case of a coherent target, the processes involved in the transfer do not include a rise in the body temperature of the target; but, where the target particles are loosely held and the current density is high, it has been possible to see the characteristic colour of the metallic vapour, indicating a kind of instantaneous vacuum distillation. The bombardment appears to produce positive ions of the metal, rather than neutral atoms, since it was possible to focus them back to the cathode by the focusing action of the electric field between the target and test cathode.

Electron microscope studies of the cathode surface showed the brightening arising from the building up of one or more layers of electropositive material; indeed, the enhanced space current is very likely due to 'thin film' emission.

The threshold bombarding voltage varies from element to element. It is usually high, of the order of some hundreds of volts, and both voltage and total energy appear to be necessary factors in the build-up.

It is hoped to publish these results in full at a later date.

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Selective Hydrogenation of Polyethenoid Fatty Compounds: a Possible Mechanism

IT has long been known[1,2] that, when a mixture of linoleic and oleic glycerides is catalytically hydrogenated, the linoleic groups are reduced to the mono-ethenoid condition before any appreciable quantity of saturated (stearic) glycerides is produced. Whereas this selectivity is extremely marked in glycerides or other mixtures of unsaturated esters, it is much less prominent when corresponding mixtures of unsaturated acids are hydrogenated[3]. Further, Richardson *et al.*[3] observed that selectivity is not so fully developed during hydrogenation of whale or other marine animal oils, wherein polyethenoid acids of the C_{18}, C_{20} and C_{22} series are prominent; and Harper, Hilditch and Terleski[4] showed that up to a very late stage in the hydrogenation of whale oil or cod liver oil, definite proportions of unsaturated glycerides containing more than one ethenoid group persist.

In 1944 Lemon[5] showed that, in the first phase of hydrogenation of linolenic (Δ9,12,15-octadecatrienoic) glycerides, considerable amounts of a Δ9,15-octadecadienoic derivative are formed, the central (Δ12) ethenoid group having been selectively hydrogenated. Lemon's observations were recently confirmed and extended by Bailey and Fisher[6], who have given evidence (i) that Δ9,12- or Δ12,15-octadecadienoic compounds are produced concurrently with the Δ9,15-isomer (and probably in about the same total proportion); (ii) that, contrary to the almost completely selective conversion of linoleic (Δ9,12-octadecadienoic) compounds to mono-ethenoid compounds, linolenic groups appear to pass partly into mono-ethenoid forms concurrently with the hydrogenation of other linolenic groups to the diethenoid compounds (i); and (iii) that the relative rates of hydrogenation ('reactivities') of oleate, Δ9,15-octadecadienoate, linoleate (Δ9,12) and linolenate (Δ9,12,15) groups are approximately in the ratios 1 : 3 : 20 : 40.

It seems to me that all the above evidence (some of which at first sight appears almost contradictory) is in harmony with the concept that what has hitherto been termed "selective hydrogenation of polyethenoid aliphatic compounds" is in fact restricted to, and a function of, compounds in which a single $-CH_2-$ group separates two ethenoid groups; and that the mechanism of the selective addition of hydrogen to the unsaturated system is almost certainly connected with the ready detachment of a hydrogen atom from the central $-CH_2-$ group in this position:

$$-CH{:}CH.CH_2.CH{:}CH- \quad \text{(diethenoid, linoleic)}$$
$$-CH{:}CH.CH_2.CH{:}CH.CH_2.CH{:}CH- \quad \text{(triethenoid, linolenic).}$$

In the analogous case of the action of molecular oxygen (autoxidation) on compounds which contain these unsaturated systems, Farmer *et al.*[7] have shown that the products consist of hydroperoxides of the form $-CH(OOH).CH{:}CH-$; moreover, in the di- and tri-ethenoid systems under discussion, they have suggested that under the influence of oxygen a system $-CH{:}CH.CH.CH{:}CH-$ is transiently produced, since partial isomerization to conjugated forms $-CH{:}CH.CH{:}CH.CH_2-$ (or the corresponding hydroperoxides) takes place. Gunstone and Hilditch[8], confirming and extending these observations, have shown further that the relative rates of autoxidation of methyl oleate, linoleate and linolenate under comparable conditions are approximately in the ratios 1 : 12 : 25, and have commented upon the great increase in activity of the 'reactive' methylene group when it is in juxtaposition to an ethenoid group on either side.

It will be noticed that the relative reactivities of hydrogenation for oleates, linoleates and linolenates observed by Bailey and Fisher[6] are markedly similar to the corresponding rates of autoxidation; and that in both cases the effect of the grouping $-CH{:}CH.CH_2.CH{:}CH-$ is to increase the rate to 12–20 times that for the monoethenoid system, whereas introduction of a second 'reactive' $-CH_2-$ group merely again doubles the rate. While direct evidence that the 'reactive' $-CH_2-$ group is involved in the action between catalyst, hydrogen and unsaturated complex is, of course, non-existent, this hypothesis appears not unreasonable since it accounts fully for the following observed facts:

(i) The almost completely selective hydrogenation of the Δ9,12-octadecadienoic grouping, and the production of Δ9,15- (as well as Δ9,12- and Δ12,15-) octadecadienoic compounds from Δ9,12,15-octadecatrienoates.

(ii) Since the Δ9,12,15 compound (linolenate) contains *two* 'reactive' $-CH_2-$ centres, simultaneous action at both centres in the same molecule is possible, leading to some direct conversion of linolenic to monoethenoid groups (as observed by Bailey and Fisher[6]).

(iii) Since some of the poly- (tetra-, penta-, hexa-) ethenoid glycerides of marine animal oils contain the group $-CH{:}CH.[CH_2]_2.CH{:}CH-$ as well as $-CH{:}CH.CH_2.CH{:}CH-$, those unsaturated systems in which a 'reactive' $-CH_2-$ group is not present will not exhibit 'selective hydrogenation' (*cf.* Richardson *et al.*[3]; Harper *et al.*[4]).

Moreover, products of partial hydrogenation of poly-ethenoid compounds (for example, in the marine animal oils mentioned, and also the Δ9,15-octadecadienoate from linolenate) may no longer contain the grouping $-CH{:}CH.CH_2.CH{:}CH-$ and will not exhibit the selective phenomenon. (Thus, Bailey and Fisher[6] give the relative 'reactivities' of Δ9,15- and Δ9,12-octadecadienoates as 3 : 20.)

(iv) The much lessened selective action in mixtures of unsaturated *acids* (as compared with corresponding *esters*) is likewise explicable, since an additional strongly polar group (—COOH) is then present to compete with the 'reactive' $-CH_2-$ groups and thus upset the chemi-sorption equilibrium between the latter and the hydrogenation catalyst[9,6].

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A Simple Fluorescent Indicator

A SULPHONATION product of hydrochinol (1,4-dihydroxybenzene) described as 1,4-dihydroxybenzene disulphonic acid, or disulphohydrochinol, shows in an alkaline medium a strong blue fluorescence, especially in ultra-violet light. It is not a new substance. It was prepared last century by A. Seyda[1], who, however, did not record its fluorescence. Seyda's method of preparation was somewhat complicated. A simpler method was described by H. Kauffmann[2], the well-known worker on the relation between absorption of light and chemical constitution of organic compounds. He recorded the fluorescence.

A fluorescence limit for a solution in water of disulphohydrochinol is *p*H 6–7. At *p*H 8 the solution turns yellow. This compound is therefore a very useful fluorescent indicator. On account of its hygroscopic qualities, it is advisable to use the potassium salt. A few drops of a 0·1 per cent solution are enough for one titration. On the acid side the solution is not fluorescent in ultra-violet light; on the basic side it shines bright blue.

Even the purest preparation shows in alkaline solution a strong blue fluorescence. In this way the objections raised by A. Hantzsch[3,4], who stated the fluorescence is due to an accompanying impurity, are disproved. On the other hand, H. Kauffmann's[2] deductions are corroborated.

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Behaviour of Activated Iron in Sodium Hydroxide Solutions

AFTER it had been shown that strong corrosion of iron may occur in alkaline solutions in the presence of special reagents[1], the question arose regarding the corrosion conditions in the absence of the organic reagent, that is, in solutions of pure alkali hydroxide. The literature on this point is rather meagre. It has now been found that in this case also there is a decided difference between activated and non-activated iron, which, however, is generally not visible during the first days after activation but appears very slowly. After about a week, the surface of the activated iron assumes a dull lead-like appearance, thereafter turning darker and darker. After a rather long time the surface finally turns brownish, rust-like. The time needed for the whole procedure seems to vary widely with the conditions of the experiment, but several months may pass before the final state is reached. Oxidising substances, added to the alkaline solution at the

time when the surface of the iron shows a lead-like colour, rapidly oxidize the lead-coloured substance to a brownish one, whereas they have no visible effect on iron not activated. The difference between activated and non-activated iron can, of course, be shown immediately after the activation by the addition of a suitable organic reagent, such as nitrosoguanidine. However, it can also be shown by the addition of an alkaline copper tartrate solution, which produces a brilliant coating, often in several colours, on the activated metal.

In most cases the concentration of the sodium hydroxide was 2-5 *N*. The activation was carried out either by mixing the iron material (screws, nails, pieces of soft iron wire) with small amounts of zinc or aluminium or by means of an external current. The experiments were made at room temperature. Further details will be published later.

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[*Nature*, **157**, 550 (1946).]

Effect of Unsaturated Fatty Acids on the Acid Production of *Lactobacillus helveticus*

WE have recently described the effect of certain unsaturated fatty acids upon growth and acid production of *Lactobacillus helveticus* and other Gram-positive bacteria[1-3]. When added to the culture medium in a concentration of about 1 : 100,000, linolenic, linoleic and oleic acids, in that order of efficiency, inhibit the growth of these bacteria. The inhibition can be reversed by the addition of similar concentrations of certain surface-active agents, such as cholesterol or lecithin. We have suggested[2] that these phenomena may be of a physico-chemical nature.

In the case of two unsaturated fatty acids we have since tested for inhibitory activity the *trans*-isomers of the naturally occurring *cis*-forms. The *trans*-forms differ from the *cis*- in their molecular structure, length of crystal cell and surface area of monolayer.

Effect of α- and β-elaeostearic acids. It was not possible to test α-elaeostearic acid or its optical isomers by the methods originally described[1-3], as these substances did not remain stable during aerobic incubation at 37° C. The method adopted therefore was to dissolve the unsaturated fatty acid in ethanol, to add it with sterile precautions to autoclaved media, and to incubate the tubes anaerobically in carbon dioxide. Under these conditions reproducible results were obtained.

TABLE 1. ACID PRODUCTION OF *L. helv.* UNDER ANAEROBIC CONDITIONS (IN CARBON DIOXIDE).

	0·1 *N*-acid formed, ml. (24 hours)	0·1 *N*-acid formed, ml. (48 hours)
10 ml. $CHCl_3$-extracted medium*	4·9	15·6
10 ml. $CHCl_3$-extracted medium + 160 μgm. linoleic acid	0	0
10 ml. $CHCl_3$-extracted medium + 160 μgm. α-elaeostearic acid	1·8	10·9
10 ml. $CHCl_3$-extracted medium + 160 μgm. β-elaeostearic acid	6·1	16·4
10 ml. $CHCl_3$-extracted medium + 160 μgm. elaidic acid	6·1	15·4
10 ml. $CHCl_3$-extracted medium + 160 μgm. oleic acid	0	2·0

* The riboflavin-free medium used was improved[3] to give higher acid production than that used in experiments in Table 2. Riboflavin was added in amounts of 0·5 μgm. per tube.

As noted in Table 1, α-elaeostearic acid in concentrations of 160 μgm. per 10 ml. medium depressed the acid production of *L. helveticus* considerably for 48 hours, whereas the *trans*-isomer, β-elaeostearic acid, was without inhibitory activity. That α-elaeostearic acid was less efficient than linoleic acid may have been due to partial destruction of the former even under anaerobic conditions.

Effect of oleic and elaidic acids. When the lactobacilli were grown aerobically in presence of oleic acid and elaidic acid, respectively, the oleic acid inhibited growth and acid-production completely for the first 24 hr. of the incubation period (Table 2). Elaidic acid (the *trans*-form), however, did not show any inhibiting effect. A similar result was also obtained when both acids were added under the conditions described above, that is, after autoclaving and incubating anaerobically (see Table 1).

TABLE 2. ACID PRODUCTION OF *L. helv.* UNDER AEROBIC CONDITIONS.

	0·1 *N*-acid formed, ml. (24 hours)	0·1 *N*-acid formed, ml. (48 hours)
10 ml. $CHCl_3$-extracted medium*	2·8	7·9
10 ml. $CHCl_3$-extracted medium + 160 μgm. oleic acid	0·4	2·3
10 ml. $CHCl_3$-extracted medium + 160 μgm. elaidic acid	2·3	8·7

* The riboflavin-free medium used was that of Kodicek and Worden[3]. Riboflavin was added in amounts of 0·5 μgm. per tube.

In the case of these two pairs of optical isomers, therefore, the *trans*-forms do not inhibit the acid-production of *L. helveticus* under conditions which permit the naturally occurring *cis*-isomers to do so. The behaviour of the *trans*-forms on surfaces would differ from that of the *cis*-forms, and the results obtained in these experiments are therefore in keeping with the physico-chemical hypothesis of the inhibitory effect[2], although they do not necessarily exclude a purely chemical interaction.

We are indebted to Prof. T. P. Hilditch for suggesting these experiments and for supplying us with specimens of elaidic, α-elaeostearic (m.p. 46·5° C.; $E^{1\ per\ cent}_{1\ cm.}$ at 268 mμ = 1770), and β-elaeostearic (m.p. 71·2° C.) acids. Dr. T. Moore very kindly helped us with the preparation of a second specimen of α-elaeostearic acid (m.p. 46·3° C.) since the original sample deteriorated rapidly as the result of polymerization or oxidation.

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Alcohol-Soluble Osteogenetic Substance from Bone Marrow

IN an interesting communication in *Nature*[1], Prof. Lacroix has reviewed his investigations of an osteogenetic substance which can be extracted from the bone tissue with alcohol, and for which he proposes the name 'osteogenin'. We should like, however, to point out that this substance has already been reported by Levander[2], Annersten[3] and Bertelsen[4]. We are at present engaged in a more detailed investigation of its chemical nature. In experiments performed in collaboration with Dr. Hans Bohr, we have confirmed Annersten's finding that the osteogenetic substance can be shaken out from its alcoholic solution with benzene. Furthermore, by saponification we have divided the lipid substances in the bone marrow into (*a*) the unsaponifiable fraction, (*b*) the fatty acid fraction and (*c*) the residual solution after saponification and extraction of (*a*) and (*b*). The osteogenetic activity in (*a*) was very low, that in (*b*) somewhat higher, while fraction (*c*) was completely inactive. The investigation is being continued.

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Choline Esterase and its Specificity

A SPECIFIC choline esterase is an enzyme which hydrolyses acetylcholine at a higher rate than any other esters[1]. Richards and Cutkomp[2], however, have found that choline esterase from insect nerves is more active on acetyl-β-methylcholine than on acetylcholine. I have also arrived at similar results with other invertebrates[3]. Thus the whole animal of *Patella vulgata*, and the ampulla and podia of *Asterias rubens* from the west coast of Sweden, split acetyl-β-methylcholine at a higher rate than acetylcholine. Benzoylcholine is very little split. In contrast to this, *Terebratulina caput serpentis* hydrolyses acetylcholine but neither acetyl-β-methylcholine nor benzoylcholine.

Characteristic of the specific choline esterase is said to be the inhibition of the enzyme by excess of substrate. Moreover, acetyl-β-methylcholine but not benzoylcholine is hydrolysed by it. If we compare the activity-*pS* curves (*pS* is − log molar concentration of the substrate) with acetylcholine and acetyl-β-methylcholine as substrates, these curves might have the same shape. I have done this with different materials and have found that it is actually the case for the choline esterase of brain and red blood cells. It is not so, however, for the choline esterase in the blood of *Helix pomatia*. Thus hydrolysis is depressed when the substrate concentration is above the optimum when the substrate is acetylcholine but not when it is acetyl-β-methylcholine. The optimum substrate concentration for acetylcholine is about $2{\cdot}6 \times 10^{-4}$ *M*, for acetyl-β-methylcholine 10^{-1} *M*. In another respect also the choline esterase in *Helix* blood seems to be distinguished from the specific esterases in, for example, brain and erythrocytes from higher animals or in other tissues from *Helix*. The hydrolysis of acetylcholine by blood from the edible snail seems to be a zero-order reaction, that of acetyl-β-methylcholine a first-order reaction. Acetylaneurin is split at the same rate as acetyl-β-methylcholine, tributyrin at a lower rate; benzoylcholine and ethyl acetate are practically not hydrolysed at all.

Among other tissues investigated from *Helix pomatia*, the dart sac is surprisingly active as regards choline esterase; thus *Q* is 10; for comparison, *Q* for the choline esterase of frog muscle is 0·4–0·6[4]. The activity is very distinct from that of the snail blood. The hydrolysis of acetylcholine by choline esterase in the dart sac is not depressed by high substrate concentrations; thus this enzyme should be called 'pseudo'-choline esterase. Benzoylcholine is not at all or only slightly hydrolysed, while acetyl-β-methylcholine is even somewhat more attached. Extracts of this tissue do not split acetylaneurin and ethyl acetate. The activity against tributyrin, on the other hand, is higher relatively than that of choline esterase in *Helix* blood.

These results will shortly be discussed more fully elsewhere. We may, however, conclude that the last word has not been said regard-

ing the specificity of the acetylcholine esterase (cf. ref. 5). The reactions used to distinguish between a 'true' and a 'pseudo'-choline esterase with the help of two choline esters (acetyl-β-methylcholine and benzoylcholine)[6] do not tell the complete story about the types of this enzyme.

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Excretion of Lead in the Bile

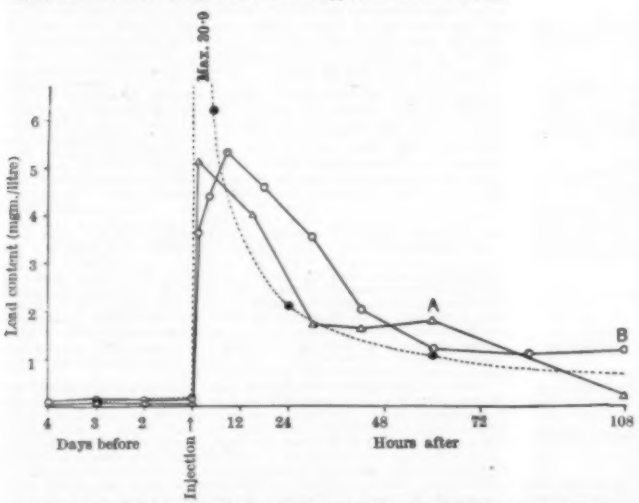
In the course of experiments by one of us[1], it was found that when single doses of soluble lead salts were injected intravenously in the sheep, only 5–8 per cent of the amount injected was excreted during the five days following injection, most of the lead being retained by the tissues. Of the lead excreted during this period, the greater quantity was found in the fæces as shown in Table 1.

TABLE 1. PERCENTAGE OF EXCRETED LEAD FOUND IN FÆCES AND URINE OF INTACT SHEEP.

Amount of lead injected (mgm.)	Percentage of excreted lead found in Fæces	Urine
10	68·8	31·2
50	74·4	25·6
100	76·7	23·3
200	80·8	19·2
400	83·2	16·8

In these experiments the excretion of lead in the urine was immediate, corresponding with the high plasma-level, but fæcal lead excretion was delayed for 4–5 days. These facts suggested that lead was excreted high up in the alimentary tract, for the passage of food residues from colon to anus could scarcely take four days. This was indirectly confirmed by the fact that disburdening of *Nematodirus* sp., a normal inhabitant of the small intestine, occurred at the same time as the peak in fæcal lead excretion in one of the experimental sheep. For this reason an experiment was carried out with a sheep in which complete biliary drainage had been accomplished by a modification of Schoregge's method[2]. Following recovery from the operation, bile, urine and fæces were collected every day from this sheep before and after the slow injection of 150 mgm. of lead as the acetate in normal saline. Lead was determined, by a modification of Fischer and Leopoldi's method[3], using diphenyldithiocarbazone. The concentration of lead in bile and urine is shown in the accompanying graph and the calculated excretion is shown in Table 2.

The graph shows that both biliary and urinary concentrations of lead were enormously increased following the injection, and the close relationship between blood lead and bile and urine lead concentrations will be noted. The curve of concentration of lead in the urine, however, is not smooth, owing to a high value at point *A*, and afterwards low values. This high concentration appeared due to the onset of anuria on the fourth day after the injection, while the subsequent low values were associated with an excessive polyuria. The reason for the delay in the maximum for the biliary lead is not clear, but may be related to breakdown of liver cells.



LEAD CONCENTRATION IN BILE, BLOOD, AND URINE FOLLOWING INTRAVENOUS INJECTION OF 150 MGM. LEAD.

A, commencement of anuria; *B*, of polyuria; o—o, bile; Δ—Δ, urine; ●....●, blood.

TABLE 2. EXCRETION OF LEAD FOLLOWING THE INJECTION OF 150 MGM. LEAD.

Hours after injection	Additional lead found in Urine mgm.	Urine % of total	Bile mgm.	Bile % of total	Fæces mgm.	Fæces % of total	Total lead excreted (mgm.)
0–24	0·70	15·8	3·87	87·4	—	—	4·43
24–48	0·74	21·3	2·63	76·6	0·09	2·1	3·46
48–72	0·21	23·6	0·68	76·4	0·00	0·0	0·89
72–96	*0·00	0·0	0·49	96·1	0·02	3·9	0·51
96–120	0·06	14·1	0·31	71·4	0·07	14·5	0·44
120–142	0·19	13·4	0·99	69·8	0·24	16·8	1·42

* No urine passed for 24 hours.

Table 2 shows that the biliary excretion accounted for the larger part of the excretion of lead by the sheep. Over the six-day period, only 7·4 per cent of the injected lead was excreted, and of this amount 17·1 per cent was in the urine, 80·7 per cent in the bile and 2·2 per cent in the fæces. From Table 2 it appears that some excretion does occur through the wall of the gut, and from the time-relationship of the excretion it appears that this is an excretion by the small rather than the large intestine. One interesting observation made was that the normal bile volume per day of 450–500 ml. increased to more than 950 following the injection and then declined to below the normal amount. The sheep died on the seventh day following the injection; serial blood analyses showed a severe anæmia and a considerable nitrogen retention associated with an increase in blood inorganic phosphorus and a fall in blood chlorine. In view of the damage to the kidneys shown by histological sections, a diagnosis of uræmia was made.

The fate of lead injected into the bile-fistula sheep extends the results of the previous experiments on intact animals, shows that in the sheep the bile is the most important single channel for lead excretion and is of interest in view of Anderson's[4] recent observation on the lead content of biliary calculi.

Our thanks are due to Mr. G. T. Snell for technical assistance, and one of us (A. T. C.) is indebted to the Agricultural Research Council for a research grant.

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Masculinizing Influence of Cystic Ovaries in Female Guinea Pigs

DURING the past few years, about a hundred guinea pigs have been ovariectomized in connexion with a series of experiments on the hormonal control of reproduction. A number of animals had cystic degeneration of both ovaries, and it was noticed that these particular guinea pigs were physically very similar to the male of the species. On the basis of this observation, it was afterwards possible to predict a cystic condition of the ovaries from the external appearance of the animals—in fact, the attendant responsible for their welfare could, latterly, confidently prophesy the operation findings. The pathognomic feature was the altered thoracic contour, particularly the greater anteroposterior diameter, resulting in a postural change in virtue of which these females resembled the male. There was, in addition, hypertrophy of the clitoris, and their weight exceeded that of the average female.

All these animals had been observed for some time prior to operation, had had fairly regular œstrous periods, and the cytology of the vaginal smears showed only minor abnormalities.

The post-operative history of the affected animals and their later reactions to hormonal treatment differed in no way from that of the spayed normal females.

There was no record of abnormal sexual behaviour before operation. Young, Dempsey, Hagquist and Boling[1], who have made an extensive study of 'mounting activity' in guinea pigs, relate this type of sexual behaviour to the maturation of more than the average number of follicles and not to a cystic degeneration of the ovaries, which they find, on the contrary, associated with a total absence of heat. Nevertheless, bilateral cystic degeneration of the ovaries

in domestic animals is exteriorized in abnormal sexual behaviour, for example, nymphomania in the cow, the horse and the sow. The symptoms of this condition are abolished by ovariectomy.

The totality of qualities constituting male or female cannot be expressed as a simple equation—male or female equals the result of the activity of the appropriate male or female sex hormone. The ovary secretes œstrogen, progesterone and an androgen[3], and the testes secrete testosterone and an œstrogen[3]. The summation of the synergistic action of œstrogens and androgens probably plays a part in the control and maintenance of the sexual characteristics, while the morphological range of sex characters and variation in sexual behaviour possibly bears some relationship to the interaction of different quantitative combinations of the two steroids.

The cystic condition of the ovaries upsets the normal hormonal balance of the individual. The heightened sexual excitement of the cow with nymphomania suggests an excess of the heat-producing œstrogens, and in this condition the ovarian cysts are exclusively the result of pathological changes in the ovaries, which destroy the primitive ova and cause an excess secretion of follicular fluid[4].

No histological examination was made of the ovarian cysts of our guinea pigs, but the masculine appearance, together with the absence of behavioural manifestations of heat recorded by Young[1], implies an increased androgenic influence.

It is known that the sex hormones influence not only the growing but also the adult skeleton[5]. In the cow suffering from nymphomania, there is a change in the morphology of the buttocks due to relaxation of the pelvic ligaments, and the bones become unduly fragile[6]. One of the most interesting of the skeletal changes mediated by the sex hormones is the laying down of medullary bone in the long bones of birds during the preovulatory phase of the cycle and the reversal of the process during calcification of the egg-shell[6]. According to Bremer[7], the balance between œstrogens and androgens may maintain normal control of the shape of the long bones in mammals. It is therefore reasonable to assume that an alteration of this balance by an increased secretion of androgen due to the cystic condition of the ovaries can effect the changes observed in our animals.

It is on record that follicular or lutein cysts can be induced by various experimental procedures: in young rats by testosterone[8]; in baboons by a combined treatment with œstradiol and progesterone[9]. It is likely that these methods operate by causing an imbalance of the gonadotrophic hormones[10]. In our own experimental material we found no excessive cyst formation (certainly nothing comparable to a cystic degeneration of ovaries) after injections of testosterone[11], 'Antostab'[12] or 'Synapoidin'[13] into immature female guinea pigs, or after injections of large doses of œstradiol monobenzoate into immature and adult guinea pigs and rats[14,15,16].

Diet, close confinement, hereditary predisposition, have each been proffered as an etiological factor in the cystic degeneration of the ovaries of domestic animals, but the fundamental cause of the condition still remains unknown.

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Structure of the Cuticle of Wool

THE flattened cells, forming the imbricated scaly sheath of the keratin fibres, wool and hair, appear comparatively structureless under the optical microscope; using the electron microscope (R.C.A. Type EMU), however, we have been able to distinguish several component structures of the cuticle cells of wool both by their appearance and by their resistance to chemical and enzymic attack.

In Fig. 1, which illustrates the cell structure diagrammatically, we have indicated two components k_1 and k_2. On the surface lies a comparatively smooth and featureless layer k_2. This is readily removed by tryptic digestion, exposing the resistant k_2 component, which presents a characteristic uneven pitted surface. Prolonged enzymic retting leaves k_2 unchanged, suggesting that the two components are sharply distinct.

In addition to removing k_1 from the scale cells, tryptic digestion of whole fibre also removes from the cortex an intercellular cement, thus causing the whole wool fibre to disintegrate. The similar ease of digestibility by enzymes suggests that k_1 and the intracellular cement are similar. Woods[1] has already given reasons for thinking that the intercellular material is also the continuous matrix of the cortical cells, which are regarded as regions within the matrix reinforced by a third variety of keratin in the form of longitudinally aligned fibrils. If we identify our k_1 with the intercellular cement, then this component is seen to form a continuous phase throughout the fibre, in which are embedded the more resistant components defining the 'cellular' regions.

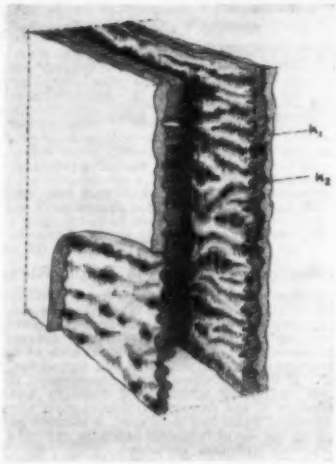

Fig. 1. STRUCTURE OF CUTICLE CELL OF WOOL RECONSTRUCTED FROM ELECTRON MICROGRAPHS. THE CELL IS APPROXIMATELY 1 μ THICK.

Similar electron diffraction patterns consisting of three diffuse rings (spacings 1·07, 1·97 and 4·28 A.) have been obtained by us from k_2, cortical cells (possibly contaminated with k_1), and films prepared from solutions of whole fibre, indicating features of molecular structure common to all.

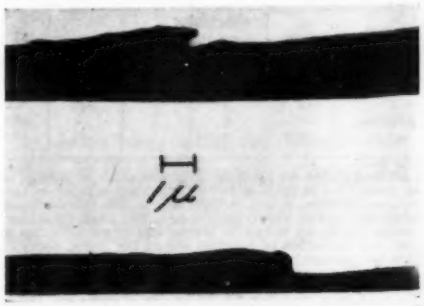

Fig. 2. (*a*) ABOVE, ELECTRON MICROGRAPH OF TYPICAL CUTICULAR PROFILE OF UNTREATED WOOL FIBRE. (*b*) BELOW, TYPICAL PROFILE OF CUTICLE FROM WOOL FIBRE TREATED WITH SULPHURYL CHLORIDE IN WHITE SPIRIT.

Chemical reagents also attack k_1 preferentially, but the action is not so precisely discriminating as that of enzymes. Of particular interest is the action of reagents under conditions which render woollens 'unshrinkable'. Any chemical reagent capable of attacking keratin can yield an 'unshrinkable finish' if the action is confined to the scales. The shrinkage of wool arises from the fact that the fibres are rougher one way than the other, which causes a persistent unidirectional migration of the fibres leading to tangling[2]. Shrinkage reduction treatments have been shown[2,3] to reduce the frictional difference (with and against the scales) of the individual fibres. Electron micrographs of the cuticular profile (Fig. 2 (*a*)) show clearly the overlapping ratchet-like edges of the scales. Similar profiles of treated fibres show that the initial attack of the reagent is at the overlapping edge, rounding it off and destroying the re-entrant angle (Fig. 2 (*b*)). When an untreated fibre is rubbed against a rough surface the frictional difference no doubt arises from the ratchet effect of the scales, and the rounding off of their edges can be expected to reduce the difference. When rubbed on a smooth surface, such as polished glass, a difference in friction still exists, but in this case a mechanical ratchet effect is not possible and some other explanation is needed. The fact that the scale edge is not sealed down to the underlying scale, but is relatively free, lends support to the model suggested by Rudall (Speakman and Menkart[4]). The destruction of the overlapping edge would also reduce this cause of unsymmetrical friction.

A full account of this work, illustrated by electron micrographs, will be published elsewhere.

We wish to thank Miss H. P. Meggs for preparing the drawing for Fig. 1.

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Formation of Polymers in Textile Fibres

When wool fibres are exposed to the vapour of ethylene sulphide and water at 50° C., polymerization takes place within the fibres, their elastic properties are modified, and felting is prevented during subsequent working in soap solution[1]. Similar reactions take place with other monomeric vinylidene compounds, such as methyl methacrylate, if the fibres are first impregnated with ammonium persulphate as a catalyst[2]. It would obviously be a convenience, in practice, if polymers could be formed within wool fibres by treatment with aqueous dispersions of the corresponding monomers instead of with the mixed vapours of water and monomer. A solution to the problem has been found in the use of immobile catalysts, such as iron (Fe++), in conjunction with hydrogen peroxide[3].

Patterns of an all-wool flannel, each 2·5 gm. air-dry, were immersed in 0·2 per cent ferrous sulphate solution, squeezed, dried and then treated with a mixture of water (200 c.c.) and either methyl methacrylate (10 c.c.) or acrylonitrile (10 c.c.) for one or two hours at 95°–100° C. in presence and absence of hydrogen peroxide (0·03 per cent). For reference purposes, one pattern was treated with methyl methacrylate and water in absence of both iron and hydrogen peroxide. After treatment the patterns were washed well in running water, conditioned, and re-weighed to determine the gain in weight due to deposition of polymer. The patterns were then hand-milled for 15 minutes in 5 per cent soap solution and the resulting shrinkages are given in the table.

Monomer	Hydrogen peroxide	Ferrous sulphate	Time of treatment (hours)	Increase in weight (%)	Area shrinkage (%)
None (untreated)	—	—	—	—	50·5
Methyl methacrylate	—	+	1	20	24·5
" "	—	+	2	45	0·5
" "	—	—	2	12	—
" "	+	+	1	240	—
Acrylonitrile	—	+	1	0	48·0
"	+	+	1	32	15·5

Iron alone appears to promote polymerization of methyl methacrylate, although the reaction is very much more rapid in presence of hydrogen peroxide, which is essential to the polymerization of acrylonitrile under the above conditions. The unshrinkability conferred on the flannel by the above treatments seems to be due to the formation and deposition of polymer within the fibres, though some deposition of polymer on the outside of the fibres is unavoidable, especially when large amounts are formed. Reactions such as the preceding are important not merely in providing a simple method of making wool fabrics unshrinkable by means of polymers, but as examples of a general method of modifying the properties of textile fibres.

One of us (M. L.) is indebted to the International Wool Secretariat and the Australian Wool Board for grants which enabled him to take part in the investigation.

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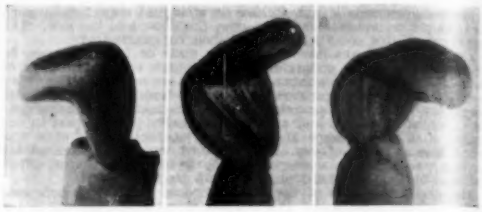
A Bent Pebble

Dr. Joseph Needham, of the Sino-British Science Co-operation Office, directed my attention to an experiment by Lord Rayleigh on a piece of crown glass under long-continued strain[1]. Lord Rayleigh's results suggest further consideration of a curiously curved, small pebble of a fine-grained quartzose sandstone briefly described elsewhere. Figs. 1 and 2 illustrate almost diametrically opposite aspects of the pebble. By turning the specimen downward from the position shown in Fig. 2 around a horizontal axis through an angle of about 35°, the view represented by Fig. 3 is obtained. These illustrations show that the pebble is equally well-rounded on all sides, characteristic of all water-worn pebbles of the lenticular shape which it would have assumed had it not been folded across the middle. A slight, abnormal inflation is noticeable in Fig. 1 on the concave side along the middle



(1) (2) (3)

zone where the curvature is the sharpest, apparently due to a localization of compression. This, coupled with the gently concave 'sky-line' seen on the top in Fig. 3 showing the transverse curvature of an anticlastic surface developed on the convex side, affords indisputable evidence for a bending at least partly of elastic nature. Such bending could only have taken place after the lenticular pebble had been formed; for otherwise the anticlastic curvature could not have escaped erosion.

An oriented chip detached from the lower part of the left-upper corner in Fig. 3 revealed, under the microscope, that the bedding planes in the original rock agreed in direction with the coarse striations present on the concave side of the pebble visible in Figs. 2 and 3; and further, it will be noticed that these coarse striations, that is weathered traces of bedding planes in the original rock, are rendered askew as they are seen on the re-entrant faces, obviously by bending around an axis which runs obliquely to the bedding plane. Finally, no such trace of dynamic metamorphism is detectable either macroscopically or microscopically, as would be usually expected to occur when the rock has undergone so severe a macroscopic deformation. Even if a structural predisposition in the original rock conducive to such a fantastic shaping be assumed, an inconceivably intricate process would still be required to produce the sculpturing and erosion. It may thus be safely concluded that we are here dealing with a distorted pebble, and not a pebble of a distorted rock unless *lusus naturæ* could be permitted a place in modern geology.

This pebble was found in a gravel closely connected to a terminal moraine on the eastern side of the mountain-range about twenty miles south-west of Kweilin. The small vanished glacier, estimated to have a thickness of 240–300 ft. at its maximum, had its sources and upper course in a pre-Devonian terrain of a regularly bedded series of shales, slates and sandstones, including the type of rock of which the pebble is composed, and its lower reach in a field of Devonian and post-Devonian limestones. Repeated searches were made across the strike of these formations, especially along the junction between the Devonian and pre-Devonian strata, with the view of locating the possible occurrence of a bed of conglomerate containing the type of deformed pebble under consideration or of any zone of locally intensified disturbance involving contorted bands of the quartzose sandstone. None of these was found; nor are they likely to occur considering the nature of the terrain.

These circumstances, together with the evidence yielded by the pebble itself, seem to remove any doubt that the pebble was in some way strained by a load due to the glacier. A planed and polished area is seen in Fig. 1 on the outer face of that portion of the pebble which is bent over to the left. This polished area is marked by a few faint strie running perpendicular to the edge on the right produced by bending. While it is admittedly unsound to attach too much significance to these details, they suggest that deformation was due to holding fast half of the pebble, as might happen by jamming in a crack of the bed-rock or in the glacier fully charged with rock debris, and leaving the other half subject to a forward thrust of the moving ice.

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Ultrasonic Velocities in Rock Sections

During the course of an investigation relating to the elastic properties of different types of sedimentary and igneous rocks employing the ultrasonic wedge method recently developed by Bhagavantam and Bhimasenachar[1], I have obtained some results which are likely to be of great importance from two or three different aspects. A preliminary report is accordingly made here.

Plates perpendicular to three mutually orthogonal directions are cut from each rock under investigation. Velocities of longitudinal ultrasonic waves with frequencies ranging from 1 to 10 megacycles along the thickness directions are determined. The results for a few selected samples are given in the accompanying table. Column 2 contains the velocity in a plate parallel to the bedding plane in the case of sedimentary rocks and to that of easy breakage in the case of others. Columns 3 and 4 refer to plates normal to two chosen mutually perpendicular directions in the above planes.

Rock	(2)	(3)	(4)
Bhima limestone	6·20 km./sec.	5·14 km./sec.	5·11 km./sec.
Jubbalpore marble	6·46	5·57	5·57
Gneiss	6·29	5·48	4·32
Pink Hyderabad granite	6·62	6·53	4·80
Diabase	7·84	6·91	4·58
Dunite	8·27	7·55	—
Deccan trap	8·61	6·97	—
Eclogite	7·84	7·84	7·78

In seismology, rocks forming the solid crust of the earth are generally regarded as isotropic or quasi-isotropic[1]. Richards[2], who studied the elastic properties of limestones, however, makes a reference to their anisotropic behaviour. The definitely anisotropic nature of various rocks with a maximum sound velocity along directions normal to the bedding plane or easy breakage planes brought out in this investigation is noteworthy, and has to be taken into account into geophysical calculations based on seismic methods. That eclogite is an exception may easily be correlated with its depth of occurrence and known uniform texture.

The full significance of these results will be discussed elsewhere.

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Origin of the First European Potatoes and their Reaction to Length of Day

WE are interested to see that Dr. van der Plank[1] has provided additional evidence for the view that the first European potatoes were short-day types from the Andes of South America rather than long-day adapted potatoes from Chile as the Russians have asserted.

We have mentioned elsewhere[2,3] that in our view the potato, when it first arrived in Europe, was probably of short-day type, but that the short-day response became modified when selection for yield took place with plants grown from true seed. Maturity in the potato appears to be governed by a large number of hereditary characters which by breeding can be easily modified either towards long-day or short-day expression. While the varieties first brought to Europe were almost certainly short-day in their reaction, there has undoubtedly been a gradual shift towards long-day types which has been accelerated as the potato crop has spread northwards and become a staple food crop.

Unfortunately, Dr. van der Plank has read into our words an inference not quite intended. Thus he states: ". . . the Cambridge school . . . agrees with the Russian in assuming that short-day Andean types would have been ill-adapted to European conditions, and postulates that if a short-day reaction existed in the first European potatoes it was something to be removed as early as possible. This view is unacceptable."

Undoubtedly the trend has been gradually to alter the photoperiodic response from short-day towards long-day, but this has taken time and we have never stated that the short-day response was removed *at once*. There is no reason why the original short-day forms from the Andes could not maintain themselves under European conditions though giving a reduced yield. This is what happens when the recently collected Andean forms are grown under the longer days of Great Britain.

Although certain old potato varieties do undoubtedly tend towards a short-day response this is by no means true of all of them. For example, the very old variety Edzell Blue is classed as an early second early and must be comparatively long-day in its photoperiodic reaction. Similarly the old varieties Bloomers, Flounders, Fortyfold and London Blue, which were all probably growing at or before the time of the potato famine (1845–46), are classed as early and early maincrop varieties and are therefore quite definitely *not* extreme short-day types. We can say, therefore, that even as early as 1830–50 many potato varieties, though by no means all, were tending towards a definite long-day response. Even the latest maturing old domestic varieties such as Gregor Cups, Lumpers, Red Cups, Rocks, Yam, etc., are not so late in maturing as varieties of *Solanum andigenum*, as comparative tests (unpublished) carried out by us have shown.

It therefore seems quite clear that even at the beginning of the nineteenth century the European potatoes had passed some distance on the way from the extreme short-day response of their South American progenitors towards the extreme long-day response of our present-day first early varieties, but the short-day character still exists in European varieties and can be recovered by breeding.

Dr. van der Plank's discovery of the Basutoland types of potato taken from Europe in the 1830's is of great interest and importance, since they would seem to be relatively unmodified relicts of the potato varieties of that time. We doubt, however, whether their photoperiodic response is so extremely short-day as the majority of varieties of *S. andigenum*, though this is a point that could be easily checked by experiment.

With the last paragraph of Dr. van der Plank's communication, on the nomenclature of *S. tuberosum* and *S. andigenum*, we are in the main in agreement. The position has already been stated by one of us (J. G. H.)[3], and further data are in the course of being compiled on the advisability of retaining the name *S. tuberosum* for all the cultivated tetraploid potatoes. This, involving the examination of type herbarium specimens and many rare documents, is a work of some length which has not yet been completed. It involves the establishment of the botanical type for *S. tuberosum*, the definition of its boundaries, and the relation of the indigenous Andean and Chilean potatoes to it.

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Trial of an Oral Vaccine against Bacterial Infection Accompanying the Common Cold

THE significance of the common cold in industry and the incapacity and loss of time that result require no emphasis. It is estimated that millions of man-days of work are lost each year as the result of upper respiratory tract infections. It seems likely that the filterable virus is the primary causative agent, and that secondary symptoms are due to bacterial infection. It was felt, as a result of reports appearing in the American medical press and in view of the shortage of labour in 1944–45, that it would be useful to attempt to immunize against secondary organisms by the use of an oral vaccine.

It was decided to carry out a large-scale experiment in the factories under my care and estimate the value of such a vaccine. The oral vaccine, if it worked, would be the only practical method of administration in a large group of workers. In collaboration with a well-known firm of manufacturing chemists, a tablet was prepared which contained the following:

N. catarrhalis	4,000 million	} in each tablet.
H. influenzæ (Pfeiffer)	4,000 "	
Streptococci	8,000 "	
Pneumococci	16,000 "	
Staphylococci	8,000 "	
Bact. friedlanderi (pneumobacillus)	4,000 "	

A tablet of the same size, colour and shape containing no vaccine but a carbohydrate compound was also prepared for administration to controls. A tablet was given daily for at least five days, and this was then repeated after a fourteen-day interval. An evaluation was attempted to show if the oral vaccine does convey an immunity, and, if so, what was its duration. The course was commenced on October 16, 1944, and results were tabulated for 34 weeks. 1,068 people were given the vaccine tablets and 985 were given the control tablets. The results from the point of view of conveying any immunity were disappointing. The results for the period showed practically the same incidence of colds in each group: 1,476 with the vaccine tablet as compared with 1,455 with the control tablet. The weekly incidence was practically the same for both groups.

These results are not in line with the published figures of the American observers, who claim good results with similar experiments but on a smaller scale; although it must be stated that the American Medical Association is not satisfied that oral vaccines are of much value.

A detailed report will be published elsewhere.

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Lantern Slides of Diagrams, Formulæ, etc.

DIAGRAMS, line drawings, tables, formulæ, etc., are best written or drawn directly on non-photographic type lantern slides. These have been variously prepared by dissolving Canada balsam in benzole[1], toluene[2], and other high boiling-point solvents. In all cases artificial heat is needed for quick drying, and a drop of the coating material (wastage) is formed in the bottom corner of the slides when stacked in a drying stand.

I have avoided these difficulties by using low boiling-point solvents, the most effective being dichloroethylene. A preparation of a 1 : 8 to 1 : 4 parts by weight of a solution of Canada balsam in dichloroethylene results in a perfectly smooth coating which takes equally well Indian ink, paint or dye, and may be written or drawn upon with any type of instrument. The solution is poured on to the centre of the glass slide, and it spreads almost immediately over the entire area of the slide. At ordinary room temperature the coating dries practically instantaneously due to the low boiling-point (55° C.) of the solvent employed.

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"Annual Review of Biochemistry"

IN his admirable review of volume 14 of the "Annual Review of Biochemistry"[1], Prof. G. F. Marrian takes marked exception to the omission of authors' names in the text and the use of bibliographic numbers only, and uses an article by Dr. Barker, Dr. Jordan and myself as the peg on which to hang his censure. My colleagues and I share his objections to the full; but we were asked by the editors of the "Annual Review of Biochemistry" to adopt this procedure and we therefore complied, although at some trouble to ourselves. Other authors may, or may not, have responded to this request, if it was made to them.

J. MASSON GULLAND.

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RESEARCH ITEMS

Pomo Ethnogeography

Omer C. Stewart (*Univ. California Pub. Amer. Arch. and Eth.*, **40**, 2; 1943) has made an intensive survey carried out on the spot, with painstaking exactitude, of the Pomo, the best-known of the Indian tribes of California. There are three principal environmental divisions of these folk, but the linguistic divisions are numerous; each of these subdivisions is described and points of interest noted. One striking feature is the way in which the linguistic areas strike across the geographical ones, so that each unit has its fair share of valley, stream and hill. Moreover, members of a community are not limited to their own ground but are allowed, by permission, to visit, say, the coastal areas to collect food there, so that all Pomo have access to the products of the entire area. Although the larger tribe could dominate the smaller ones, they do not appear to do so, but allow the minorities to possess territories providing an adequate food supply.

Archæology of South Park, Colorado

Prof. E. B. Renaud has brought out a fifth paper in an archæological series which is being issued in typescript by the Department of Anthropology in the University of Denver. The publication under notice deals with certain archæological finds made in a mountainous district to the south-west of Denver. The most common type of site is an encampment with, frequently, an adjacent workshop. Stone implements and pottery occur, and naturally several ages are represented. Folsom and Yuma points have been recognized, so fairly early phases of the Stone Age do occur.

Washo-Northern Paiute Peyotism

The religious cult of peyotism is widespread among the Indians of the United States and Mexico, where it was found by early Spanish explorers so early as 1560. The peyote is a small spineless cactus which when dried is easily transported and hence available beyond the area in which it grows. Eating the peyote produces slight intoxication combined with sensory hallucinations, and was supposed to be curative. Many records exist of these cults, which show a sufficient uniformity to allow of a general description: the purpose was to heal and protect, through the worship of God by means of peyote. This cult was first introduced to the Washo and Northern Paiute Indians in 1936 and has therefore been well documented. Omer C. Stewart (*Univ. California Pub. Amer. Arch. and Eth.*, **40**, 3; 1944) was in the field only two years after its first appearance, and was therefore able to get first-hand information from most of the original participants, while the experience was still fresh in their minds and modifications had not set in. The results of this investigation set down here are all well documented and finally tabulated. There seems little evidence of cures, though occasionally these occur, and the conclusion reached is that the majority of Indians have not yet found this cult the answer to their spiritual and physical needs.

Control of the Potato Moth

Severe losses are sustained on the mainland of Australia by attack of the potato moth, *Gnorimoschema operculella*. The pest is particularly numerous in dry seasons, and has proved difficult of control. G. A. H. Helson, however, has found that a phenothiazine spray of 3 lb. of the compound in 100 gallons of water has proved satisfactory (*J. Counc. Sci. and Ind. Res.*, **17**, 3; August 1944). Five sprayings were given, and the treatment doubled the crop. The economics of control are not, however, fully established. Lead arsenate with sodium aluminium sulphate, and synthetic cryolite, gave partial control, and basic copper arsenate was of very little effect.

South African Species of *Encephalartos*

The taxonomy of the larger genera of cycads has long been in an unsatisfactory state. Their large leaves and often bulky cones do not lend themselves readily to ordinary herbarium methods of preservation, and inadequate material in the hands of systematists unfamiliar with the living plant is responsible for the incomplete knowledge of the species and the extent to which they vary. Study of the extensive living collection of *Encephalartos* in the National Botanic Gardens, Kirstenbosch, has provided M. R. Henderson (*J. South African Bot.*, **11**, Pt. 1, Jan. 1945) with materials for a revision of the South African species of this genus of cycads. A number of species are known at present only from one or two plants, with cones of only one sex, or none, and much field work remains to be done before the variability and distribution of some even of the better known species are thoroughly understood. In this preliminary account twenty-two species, six of which are new, are recognized. They grow mostly in the eastern grasslands of Cape Colony and northwards to Natal and the forests of Zululand and Lourenço Marques. Farther inland in the parklands and grasslands of the Transvaal seven species occur, all endemic, and one ascends to 4,000 ft. in the Drakensberg Mountains. Good photographs of living and coning plants, and drawings of the cone scales and seeds are provided.

Hybridization of *Lycopersicon*

Attempts to hybridize *Lycopersicon esculentum* and *L. peruvianum* have in the past failed, the failure apparently being due to the fact that any embryos formed as a result of the hybridization collapse about forty days after pollination. D. G. Smith, however (*Proc. Amer. Soc. Hort. Sci.*, **44**, 413; 1944), reports success in culturing embryos removed from the 'seed' 35–40 days after pollination, on nutrient media. Out of about sixty embryos cultured, three grew on to mature plants which flowered abundantly, were self-sterile and sterile with *L. esculentum* but fertile with *L. peruvianum*. Development of this work may place new material at the disposal of the breeder of commercial varieties of tomato, and, in addition, throw light on the genetic problem that the genus *Lycopersicon* presents.

Dominance

L. C. Dunn and S. Glucksohn-Schoenheimer (*Proc. Nat. Acad. Sci.*, **31**, 81; 1945) have continued the analysis of the characters due to *Sd* in the house mouse. In the original stock there was an absence or shortening of the tail, absence or abnormality of one or both kidneys and absence of an anus and genital aperture. The gene *Sd* acted as a dominant regarding length of tail, and a recessive in respect to lethality. On introducing the gene into other lines the authors find different effects. In one line the heterozygotes are almost tailless and inviable; in another line the length of tail increased in the heterozygotes but the viability was lowered. In a third line the tail became shorter

but the viability increased. The authors therefore conclude that the several effects of *Sd* upon the heterozygote are modified by different genetic factors. They hold that the evolutionary significance of factors effecting dominance can be properly assessed only when their physiological effects are known.

Geology of the Lau Group Fiji

DURING 1934, H. S. Ladd and J. E. Hoffmeister made a geological study of twenty-six of the small Fijian islands known as the Lau Group. The results of their investigations, together with reports by other authors on the igneous rocks, limestones, foraminifera, echinoidea, barnacles and decapod crustaceans appear in Bull. 181 of the Bernice P. Bishop Museum (Honolulu, 399 ; 1945). The oldest rocks, andesitic pyroclasts and flows, are widely exposed and make the foundations for a series of Miocene limestones. Most of the islands are distributed on a simple grid of north-west–south-east and north-east–south-west lines, which probably represent the fractures along which the volcanic centres became established. After some truncation by wave action, limestone deposition began in the Lower Miocene. The formation is rich in algæ and foraminifera, but poor in corals, suggesting accumulation at a depth of more than 50 fathoms. A period of emergence followed with formation of numerous, and often coalescing, sink holes and caverns. A second outbreak of volcanic activity then occurred (Upper Miocene), with eruption of agglomerates and flows of olivine-basalt from several centres. Submergence during the Pliocene is indicated by the local occurrence of a shelly limestone containing coral heads. Intermittent uplift and terrace development followed the close of the Tertiary. Remnants of Pleistocene coral reefs are preserved in some of the islands and odinite lavas appeared on two of them. A detailed discussion is given of the development of the present topography. The well-known hypothesis of W. M. Davis that "all the varied features of the many islands and reefs . . . can be simply reconciled if it may be assumed that a broad and low sea-floor anticline, preceded and followed by a sea-floor syncline, has slowly migrated westward into the Fiji region" is shown to be inconsistent with many of the new observations.

Uric Acid Content of the Keratinous Integument

ABOUT a hundred colorimetric determinations (Folin, O., *J. Biol. Chem.*, **106**, 311 ; 1934) on hot aqueous extracts of defatted feathers, quills, hairs, claws, hoofs and horns obtained from sixteen different animal species representing bird, monotreme, marsupial, ungulate, rodent, carnivore and primate indicated a uric acid content ranging from 4 to 540 mgm. per cent. In approximately half the specimens tested it exceeded 100 mgm. per cent. From the fur of rabbit (A. Bolliger and M. H. Hardy, *Aust. J. Sci.*, **7**, 59 ; 1944), cat and dog, uric acid has been isolated in crystalline form and definitely identified. In other instances uricase added to the extract was found to destroy most of the chromogenic material. Therefore, comparatively large though varying amounts of uric acid were always present even in what is generally considered to be pure keratin. This indicates that uric acid is a constituent of the protein keratin.

Damping Capacity of Materials

THE information in a report by Prof. F. C. Thompson, "Damping Capacity, a General Survey of Existing Information" (London : British Non-Ferrous Metals Research Association, 1944), correlated from a survey of published works on the subject, has important applications to machine parts subjected to vibration or rapidly alternating stresses. Definitions of damping capacity differ considerably, but in general it may be expressed as "that property of a solid in virtue of which it can, of itself, dissipate internal vibrations, and hence prevent their attaining dangerous dimensions". The report discusses the physical and mechanical meaning of damping, and the relationship to the elastic properties of materials ; the influence of metallographic factors such as crystal structure and the effect of the frequency of the stress cycle. The experimental measurement of damping capacity receives considerable attention and discussion in detail, such widely different methods as calculation from the normal stress-strain diagram and measurements of the rate of decay of electrically induced high-frequency vibrations being applicable for this purpose. The different methods of measurement and of expressing the results naturally lead to variations in the value of the figure used to express the damping capacity of a material, and the author concludes by suggestions for the development of not more than two standard methods of measurement which would cover the field of practical requirements. A bibliography of fifty-eight references is included.

Steady-State Equilibrium of Parallel Alternators

A PAPER by Dr. J. C. Prescott (*J. Inst. Elec. Eng.*, **92**, Pt. II, No. 28 ; August 1945) describes graphical methods of determining the equilibrium values of voltage and load for systems of paralleled generators working under certain specified conditions. Two main cases are considered : that of a number of synchronous machines in parallel supplying a load of constant power factor, when the operating voltage on a given load and the maximum stable load are to be determined ; and that of a number of machines working on constant load, when the variation of voltage with changing power factor and the minimum power factor for stable operation are required. The principle of the methods is also extended to the determination of the reactance of the symmetrical three-phase fault which will just render unstable a system of generators each of which makes a specified contribution to a constant total load of known power factor. These solutions require certain assumptions, of which the more important are that the impedance of the interconnecting lines is negligible compared with the impedance of the alternators, and that, neglecting the resistance component and making some assumptions with regard to saturation, the impedance of the alternators can be represented as a reactance of known constant value.

Current Transformer Errors

THE flux density in a current transformer depends upon core proportions, frequency, ampere-turns and total burden. The errors are usually estimated by reference to data curves for the core material in which specific loss and magnetizing voltamperes appear as functions of flux density. While step-by-step calculation is simple and straightforward in individual cases, there is some advantage on general grounds, in view of the number of factors involved, in grouping these factors in a systematic manner which allows the whole position to be reviewed. An attempt to do this is made in a paper by G. F. Freeman (*J. Inst. Elect. Eng.*, **92**, Pt. 2, No. 27, June 1945) and the resulting formulæ are alternatively expressed in chart form for quick reference.

STAGE OF DETERMINATION OF VERTEBRÆ IN TELEOSTEAN FISHES

By Dr. Å. VEDEL TÅNING
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THE question, at what period during ontogeny is the number of vertebræ determined in teleostean fishes, has been asked by several workers studying racial characters in fishes, but without answer owing to lack of adequate experimental work.

The study of meristic characters in various fishes has in recent years shown that such an important racial character as the number of vertebræ is liable to some variation owing to the influence of environmental factors, of which temperature seems to be the most important[1–5].

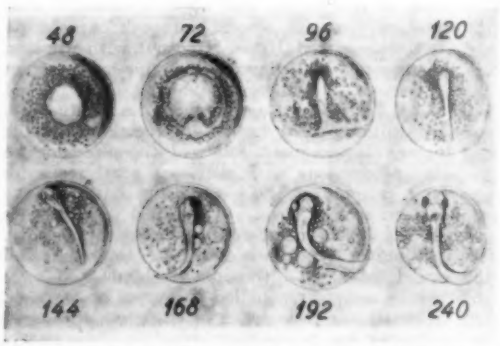
For the use of the meristic characters in applied fishery biology it is of course very important to know if the characters in question are genotypically or purely phenotypically determined; for example, in those cases where races of herring are separated from each other by differences only amounting to a fraction of a vertebra. If a rather slight alteration of, for example, the temperature during a certain stage in the developing embryo can alter the final number of vertebræ to such a degree that a change occurs exceeding several times the difference between two hitherto 'well established' races of herring, then it is of course necessary to be very cautious in using such 'races' in applied fishery biology. Two herring races established on small differences in meristic characters might be a fiction only, without other reality in Nature than the fact that spawn have developed in slightly different environments; and we know that the power of discrimination between various temperatures is very sharp in fishes. To prove that a difference in number of vertebræ in two hitherto 'well established' races of fishes is of a phenotypical nature does not of course show in consequence that such two groups are not genotypically different, but it is obvious that the proof of this must be founded on some other base than the number of vertebræ.

Experiments in, for example, trout, by J. Schmidt[4] have shown that an environmental factor, namely, the temperature, may have some effect on the number of vertebræ. Schmidt proved that at a temperature of about 6° C. the number of vertebræ in trout became low; at both lower and higher temperatures, however, a rise in the number of vertebræ was found. Several repetitions of Schmidt's experiments have given the same result.

So long as it is not yet known if the determination period (the phenocritical period) of the final number of vertebræ is situated in the post-larval stage or in a much younger stage during ontogeny, all experimental work in racial investigations of fishes is much hampered. With the aim of solving the problem I therefore carried out some experiments during the War. Unfortunately, our common marine fishes, such as herring, cod, plaice, etc., were too difficult to rear, and I have therefore used the sea-trout for my experiments on meristic characters. The first results were published in a short paper[5], showing that the determination period must be prior to the eyed-egg stage in trout. Gabriel[3] showed also that the period occurs early in the development of the marine fish *Fundulus heteroclitus* (at any rate, previous to hatching).

During my experiments I wished to ascertain when a change in the number of vertebræ may take place in relation to the age of the embryo (measured in day-degrees), and further if the change takes place suddenly or gradually. The principle used in the experiments was to transfer batches of eggs (from one female and one male only) in various stages of development from one temperature to another and then determine the number of vertebræ in the fry when fully developed (in comparison with an untreated control sample); experiments were also carried out in which samples of eggs were moved back again to their original temperature after having passed a certain period in a foreign milieu.

More elaborate experiments than those published in 1944 have now shown that in trout (and I suppose in Teleosts generally) a certain rigidity against an alteration of the number of vertebræ is present already in the gastrulation period, and if only minor changes in temperature occur after about 100 day-degrees (that is, about the twentieth day at 5° C.) but previous to about 145 day-degrees, an alteration in the number of vertebræ seems not easily introduced. The accompanying figure shows the different developmental stages here mentioned in relation to the age in day-degrees.



DEVELOPMENTAL STAGES OF EGGS OF SEA-TROUT (EGG-MEMBRANES REMOVED). THE NUMBERS INDICATE THE AGE IN DAY-DEGREES. THE TOP ROW SHOWS THE STAGES IN WHICH THE NUMBER OF VERTEBRÆ ORDINARILY IS DETERMINED; THE TWO EMBRYOS TO THE LEFT IN THE LOWER ROW ILLUSTRATE THE LIMITS OF THE SUPERSENSITIVE STAGE; THE TWO TO THE RIGHT HAVE PASSED THE FIXATION PERIOD OF VERTEBRÆ. HATCHING TAKES PLACE AT ABOUT 400 DAY-DEGREES. (DRAWINGS BY POUL H. WINTHER.)

A little later in the development there seems, however, to be a very remarkable supersensitive period of short duration: in sea-trout this period occurs when the embryo is about 145–165 day-degrees old, corresponding to the stage in ontogeny when the preformation of the last vertebræ seems to take place as the most posterior mesoderm segments. The effect of an alteration in temperature (3–6° C.) in this period is remarkable in two respects: namely, a conspicuous effect is likely, and the rise or fall in number of vertebræ is nearly always contrary to that which we should expect according to the activating temperature. Probably we have a special shock effect in this supersensitive period. It is, however, interesting that it has been possible when affecting embryos in this special period to produce a difference between full brothers and sisters of *c.* 1·5 vertebræ, which is a difference sufficient to maintain the presence of two different geographical races (or some twenty-five years ago even species) in stocks of fishes met with in Nature.

A very slight alteration of the number of vertebræ in trout is possible, however, in developmental stages even somewhat older than about 170 day-degrees, that is, roughly after the first fine pigment has begun to show in the eyes; this slight alteration has in all experiments hitherto carried out been less than about 0·2 vertebræ and seems to be connected with slight morphological alterations in the arches to the last but four vertebræ (that is, in the so-called fused vertebræ near the tip of the tail). In most cases, however, no alteration is observed in embryos older than about 170 day-degrees.

I suppose that the results achieved may prove to be valid for teleosts generally, thus suggesting that the number of vertebræ is fixed before hatching in our common food fishes. Determination of the final number of vertebræ must, in consequence of the mode of development, occur (for example, in cod, plaice and herring) during the first half to two thirds of the incubation period; this knowledge is of course valuable for studies in racial characters used in applied fishery biology. It is, moreover, of interest to see that a quantitative character (number of vertebræ) is comparable to several qualitative characters determined already in the very early stage of the developing egg, for example, in Amphibia, in which it has been shown that morphogenetic stimuli are emitted by an organiser during gastrulation. The great effect met with in the supersensitive period may probably be compared with the effect which Goldschmidt found in *Drosophila*, the result being the so-called 'phenocopies'.

Various other experiments carried out on sea-trout have revealed the fact that such other meristic characters as the number of fin rays in the dorsal, anal and pectoral fins are determined in a very early stage too, mainly previous to hatching. It has furthermore been possible to show that, besides temperature, oxygen pressure has a determining effect on the number of vertebræ, though it is small (low pressure gives a higher number of vertebræ); other environmental factors affecting the number of vertebræ have not yet been found; but it must be pointed out that research work in experimental racial studies in teleosts is still in its infancy; much more work is necessary before even the main problems are settled".

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EFFICIENCY OF FOREST ENUMERATIONS

AT the present juncture in forestry matters and the available stocks of timber in the world's forests, it would be difficult to over-estimate the value of the discussion which took place at the sixth Sylvicultural Conference held at Dehra Dun, India, in April 1945 on "The Efficiency of Enumerations". *Indian Forest Leaflets* (Sylviculture) Nos. 83, 84 and 85 (Forest Research Institute, Dehra Dun, U.P. 1945) deal with the resolutions made at the Conference and the progress so far achieved. The reason for instituting the investigations in India was due to the extra fellings rendered necessary in the well-managed forests by war demands. If such investigations are held to be so urgent in India, where so large a proportion of the State forests are under working plans, the position in large parts of the world's forests outside India where unrestricted war fellings have been carried out in the absence of any detailed knowledge of what the forests contained, or to what degree they were being over-felled, may be imagined. These leaflets come at a most opportune moment.

Leaflet No. 1 (I. The Problem) details the problem as follows:—(1) The general over-felling of the forests of India and in particular the felling of special sizes of selected species for war purposes has rendered it imperative that, as soon as the War is ended, large-scale enumerations be carried out in a number of provinces for working-plan purposes in order to estimate war damage and remaining resources. (2) Enumerations will also be necessary to provide for post-war planning. (3) The accuracy of enumerations is a matter of permanent importance. (4) At present we have little or no information of the potential accuracy of current methods of enumeration. (5) It appears probable that much useful information can be obtained fairly quickly by examination of existing data.

The Conference therefore resolved that: (1) the central sylviculturist be authorized to proceed at once with the examination of existing data, to endeavour to give an indication as soon as possible of the probable accuracy of different methods and intensities of enumeration in different types of forest and terrain; (2) approximate information is needed quickly rather than a more detailed accurate complete research; (3) the staff used for enumeration work should be of the highest quality available, and should receive extra remuneration; (4) after the examination of this data a paper or leaflet should be written on the necessity for determining the precision of sampling enumerations.

As a result work was started—Leaflet No. 84 (II. Madras Tropical Wet Evergreen Forest; III. Typical Calculations) discusses briefly the area concerned and the data available, and shows the errors in estimations of total volumes which would have occurred had "sampling enumerations of different intensities been carried out instead of a full 100% enumeration". It is emphasized that this investigation is the first of its kind in India and only deals with one type of forest. The points of chief importance are as follows. (1) Intensive and expensive 100 per cent enumerations are not necessary in order to obtain a reasonable estimate of the growing stock. Enumerations of 5–10 per cent are probably sufficient for most practical purposes.... (3) Whatever the intensity of enumeration, some thirty to sixty separate estimates of the volume per acre in each square mile of forest will probably give a sufficiently accurate estimate of the total volume and the precision of the calculation. This is an economically reasonable number of figures for the computors to handle.

In Leaflet No. 85 (IV. Madras Moist Mixed Deciduous Forest) the following indications are given as results from the investigations so far carried out: (1) Intensive and expensive 100 per cent enumerations are not necessary in order to obtain a reasonable estimate of the growing stock. For practical purposes enumerations of 5 or 10 per cent in evergreen, and of 2½ or 5 per cent in moist deciduous forest are probably sufficient.... (3) Whatever the intensity of enumeration,

some thirty separate estimates of the volume per acre in each square mile of evergreen forest and some ten separate estimates per square mile in moist deciduous forest will probably give a sufficiently accurate estimate of the total volume. These are both economically reasonable numbers of figures.

A careful study of these leaflets is strongly to be recommended to all those in charge of forest areas which have been subject to these disastrous and, in many cases, almost unchecked war fellings, admittedly practically inevitable with a war including and affecting the whole globe. India has started a wholesale stock-taking in her forests. Yet India with her highly developed network of working plans covering the State forests is probably in a far better case of knowing what is the position of the over-felling, the excess war fellings, than are most countries where forests have been subject to these heavy drains.

PLANT PHYSIOLOGY IN THE U.S.S.R.*

By Prof. ERIC ASHBY
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Laboratory of Photosynthesis

OUTSIDE the Institute of Plant Physiology research is going on in many other plant physiology laboratories. There is an independent laboratory of photosynthesis in the Academy, under Academician A. A. Richter. The laboratory has four workers: Richter, who is seventy-four; and three others, including K. T. Sukorukov. Richter's wife, who is well known under her own name of T. A. Krassnocelskaya, has the chair of plant physiology at the Pedagogical Institute in Moscow. In this laboratory photosynthesis is measured from disks of leaves in a Warburg apparatus. Recently[27,28] Richter and his co-workers have surveyed the relationship between photosynthesis and growths in some dozen different plants. They find that over long periods the photosynthetic rate remains unchanged, despite changing growth-rate and accumulation of dry matter; and it is independent of polyploidy, nitrogen-level, and length of day. These results are not simply the consequence of the controlling action of carbon dioxide under natural conditions, for in some experiments the carbon dioxide level was as high as 0·2 per cent. Richter has also surveyed the photosynthetic rates of plants of very different taxonomic positions (for example, *Ginkgo*, ferns), and he reports some large differences among them. Other lines of work in this laboratory are plastid chemistry and the physiology of immunity.

Komarov Botanical Institute of the Academy of Sciences

This institute is concerned primarily with taxonomy (under Shisbkin), plant geography (under Ilyinsky and Lavrenko), and anatomy (under Alexandrov); but there is a plant physiological laboratory where Lubimenko's work is continued by Brilliant. She is studying the effects of dehydration of the leaf on the rate of photosynthesis. A recent publication[29] confirms her earlier work, that in some circumstances there is an increase of photosynthesis after partial dehydration of the leaf. In the same laboratory Ermolaeva has worked on the effects of coloured light of different photoperiods on the growth of *Perilla*[30].

Vernadsky Laboratory of Geophysical Problems, Academy of Sciences

This laboratory was made famous by the work of the late Academician Vernadsky, and it is now under the direction of Vinogradov. Several problems of interest to plant physiologists are under investigation, notably E. A. Boychenko's work on the activity of chloroplasts outside the cell[31]. Using chloroplasts from white clover, deposited on filter paper, and working at an *r*H less than 10, with a hydrogen donator, Boychenko has produced several ml. of oxygen. Activity continues over 2–3 days. This laboratory has worked also on the mineral content of *Lemna* from various parts of the world, and the detection of rare elements by the most refined modern techniques.

People's Commissariat of Agriculture

Among the many hundreds of research institutes and stations under this commissariat there are several where plant physiological research is being conducted, notably the Institute of Plant Industry and the Institute of Physico-Agronomy in Leningrad, the Institute for Grain Culture at Nemchinovko, near Moscow, and the Institute for Grain Husbandry at Saratov.

In the field station of the Institute of Plant Industry, at Pushkin, near Leningrad (founded by Maximov in 1924), Rasumov works, though he is at present away on military service. The Institute of Physico-Agronomy is under the famous physicist, Joffe, and it is engaged in extremely interesting work on the application of physical methods to crop physiology and soil science. Kolyasev is working on the movements of water in soils. Malchevsky, who died of starvation as a result of the siege of Leningrad, did some excellent work on photo-induction[32]. Joffe's assistants are engaged on the design of ingenious instruments for measuring leaf temperature, soil surface temperature, and heat transmission through soils; and they plan to work now on the measurement of soil moisture by the use of high-velocity neutrons which are transformed to low-velocity neutrons by water in the soil. Moshkov is working on lines similar to those of Chailachjan[33]. He concludes from his experiments that there is not yet sufficient evidence for belief in the existence of flower hormones. Some of his recent experiments provide analyses of the effect of length of day on drought resistance, on frost resistance, and on dwarf forms in willows; and he has studied in a series of brilliant experiments the influence of short day on parts of leaves, and on old and young leaves, in *Perilla*. Among several interesting results he has obtained is that an old leaf requires about three times as long a period of photoperiodic induction as a young leaf, in order to produce the same effect on flowering.

In the Institute of Grain Culture, Vassilyev (well known for his work on transpiration and recently on vernalization) is now studying frost resistance; and he has recently published work on phasic development[34]. In the Institute of Fodders there is work on the mineral nutrition of grasses and the biology of pollination of lucerne. In the Institute of Grain

* Continued from page 558.

Husbandry at Saratov, Krassovskaya is working on the physiology of root systems. Pollination and the physiology of nectar secretion are being studied in Rozov's laboratory in the Institute of Bee Culture near Podolsk. In other institutes there is doubtless good work going on about which little is known, for publication is very much in arrears in the U.S.S.R. at present.

The Universities

The chair of plant physiology in the University of Moscow is held by D. A. Sabinin, whose recent book on mineral nutrition is of great importance[35]. Many plant physiologists have received their training from Sabinin, and students in his laboratory have worked in several fields, of which the following are the more important examples: (*a*) From work on the effects of organic acids on viscosity of protoplasm, Belousova considers that protoplasm is made up of a network of protein molecules, 10–20 A. apart, united by amino-acid groups. (*b*) Trudetskova has found that the Q_{10} of bleeding in a cut shoot is 3–4, whereas the Q_{10} of passive filtration of water through roots is 1·2. (*c*) Pankratova has worked on the physiology of nectar production, and has found that the effect of putting cut flowers into hypertonic solutions (0·5 molar sugar) is to increase the rate of secretion of nectar. (*d*) Shoklender has worked on the movement of phosphorus, using radioactive isotopes.

The chair of plant physiology in the University of Leningrad is held by S. D. Lvov, who is working on the physiological significance of vitamin C in plants[36] and on the biochemical basis of drought resistance[37].

Most research work done in the Universities of Moscow and Leningrad is published in "Scientific Writings" of these Universities, which are described by their initials *MGU* (Moscow State University) and *LGU* (Leningrad State University). In addition to these chairs of plant physiology, there are chairs of plant physiology in the Universities of Saratov, Kiev (where Cholodny works), and Kazan.

These are only some examples of plant physiological research in the U.S.S.R. There is space only to enumerate a few others. Cholodny is beginning a new laboratory in plant physiology at Sochi, on the Black Sea, where work on hormones is being continued. N. M. Sisakyan, who works at the Biochemical Institute of the Academy, has recently published a monograph on the "Biochemical Character of Drought-resistant Plants", where he applies the theory of the reversibility of enzymes, claiming that under conditions of drought hydrolysis increases and synthesis is inhibited[38]. The Institute for Potato Culture is working on the pre-treatment of potatoes for northern climates. Work on frost resistance is being done by the Institute of Polar Agriculture in Leningrad. Gurievitsch is still working on mitogenetic rays at the Institute of Experimental Biology of the newly formed Academy of Medical Sciences. There is scarcely any research on vernalization in the U.S.S.R. to-day. Interest in the problem has been lost, and it is realized that press reports about the process being applied on a large scale in agriculture were very greatly exaggerated.

It is clear from this sketchy review that plant physiology is flourishing in the U.S.S.R., despite the dislocations of the War. As a purely personal opinion, five tentative conclusions are advanced about the work being done. First, the suggestion sometimes made that science is constrained by political considerations in the U.S.S.R. is untrue, so far as plant physiology is concerned. Secondly, apart from some work on the causes of flowering and on physiological age-cycles, there are no strikingly original lines of research; Soviet physiologists are developing their work along traditional paths, and they freely acknowledge foreign work in their publications. Thirdly, Soviet plant physiology is almost wholly innocent of statistical treatment of data, with the result that sometimes important and striking claims are made on evidence which would not be considered adequate by a British physiologist. Fourthly, the general trend of the work is biochemical, and there is not the enthusiasm, characteristic of some British laboratories, for elaborate and ingenious apparatus. Fifthly, the applications of plant physiology to agricultural practice are distinguished by more initiative and enterprise than is generally shown by British and American physiologists.

[35] *Dok. acad. nauk.*, **45**, 275 (1945) (Russian).
[36] *C.R. Acad. Sci.*, **46**, 40, 165 (1945).
[37] *C.R. Acad. Sci.*, **41**, 129, 219 (1943).
[38] *Acta instituti botanici*, Ser. 4, 84 (1940) (Russian).
[39] *C.R. Acad. Sci.*, **38**, 181 (1943); **42**, 345 (1944).
[40] Bull. Lab. of Light Physiology, 1 (1938) (Russian; summaries in English).
[41] *Dok. acad. nauk*, **22**, 186, 189, 465 (1939); **24**, 394, 442 (1942); **31**, 700 (1941). *Sovietskaya botanika*, 32 (1940) (Russian).
[42] *C.R. Acad. Sci.*, **24**, 35 (1939); **28**, 177 (1940).
[43] "Mineral Nutrition of Plants" (1940) (Russian).
[44] Scientific Writings of Leningrad University, No. 75, 151 (1945).
[45] Scientific Writings of Leningrad University, No. 68, 54 (1944).
[46] Academy of Science Press (1940).

CIVILIAN CONTRIBUTION TO EDUCATION IN H.M. FORCES

THE report of the Central Advisory Council for Education in H.M. Forces for the six-monthly period ending in September 1945 once more shows the great contribution which has been made by civilians to the Services educational schemes. During the period under review 44,379 single lectures, 2,972 short courses, 2,242 classes and 724 intensive schools, leaders' courses and conferences are known to have been arranged through the agency of the regional committees at the universities. Current affairs continue to be far the most popular subjects demanded, but there has been a steady increase in the demand for non-vocational science classes. There was a considerable falling off in the number of vocational science classes arranged, a fact which does not admit of easy explanation.

The period as a whole must be considered in relation to the educational schemes planned for the release period by all three Services. This led to an increase in regional committee provision for intensive schools and instructors' courses, and in the extension of advisory facilities on educational matters which in many regions has become an important service both to education officers and to individual Service men and women.

Five regional committees—Manchester, Southampton, Glasgow, Nottingham and St. Andrews—provided full-time residential courses for various groups of men and women in H.M. Forces, each of the residential colleges being staffed by the Council's full-time lecturers and by members of the staff of the universities associated with the regional committees

concerned. Courses ranging from a week-end to a month were devoted to instructor training, to the general educational needs of people shortly to be demobilized, and to social and leisure interests. The value of these residential colleges in a university atmosphere has been recognized by both Forces education officers and civilians alike, and there seems little doubt that these colleges are making a distinctive contribution to Service education out of all proportion to the small numbers who can attend.

The needs of the Forces overseas have increased, and many regional committees were generous in releasing both full-time lecturers and members of their part-time panels to spend one month or more with Commands overseas; visits have already been made to Germany, Italy, Austria, the Middle East, India, Ceylon and Burma. Two of the lecturers, Dr. Gavin Henderson and Dr. J. W. Jenkins, lost their lives during their periods of work overseas.

ANGLO-AMERICAN CARIBBEAN COMMISSION

THE report of the Anglo-American Caribbean Commission to the Governments of the United States and Great Britain for the year 1944*, publication of which has been delayed by war-time shortage of staff, refers to the Land Tenure Symposium at Puerto Rico, August 27–September 2, 1944, held in accordance with a recommendation of the Caribbean Research Council, which included technical papers from specialists, informal discussions and tours of the research and educational institutions and of the land-tenure improvement projects in Puerto Rico. Questionnaires prepared and sent out by the Research Council during the year relating to crop growing and animal husbandry within the Caribbean covered sugar, livestock, grain crops, grasses and grassland management, root crops and pulses, and vegetables. The Committee on Agriculture has requested from each department of agriculture and research institution in the area a complete list of addresses to which its publications have been sent and a list of research workers within its field of specialization, from which lists it is proposed to compile for circulation a comprehensive mailing list and a list of research workers and their subjects. Dr. C. E. Charden, director of the Institute of Tropical Agriculture, Mayaguez, Puerto Rico, visited Barbados and Trinidad in December 1944 in connexion with the joint survey of agricultural research agencies to be made by him and Prof. D. D. Paterson of the Imperial College of Tropical Agriculture, Trinidad. Dr. Paterson visited Puerto Rico in the spring of 1945 and a joint report is being compiled.

Further work of the Anglo-American fishery survey during 1944 explored the resources within the Eastern Group of the British West Indies and was extended up to nine months in the waters of Trinidad, Tobago and British Guiana. The results of the otter trawling and the interest displayed by local fishermen led to the publication of a pamphlet describing the construction and use of small otter trawls suitable for local use. A report on the survey will shortly be published as a special bulletin, and a practical and comprehensive guide on shark fishing has been prepared and issued for the use of the fishermen themselves.

A joint programme for the control of venereal disease has been initiated with permanent headquarters in Port-of-Spain, and this Caribbean Medical Centre, in addition to conducting serological surveys, treating patients, and educating the public to the necessity of diagnosis and treatment, is conducting an intensive training programme of local personnel. Dr. R. Kahn visited the Centre, at the invitation of the Trinidad Government, to investigate and advise on the serological reactions for syphilis, especially in regard to the standardization of serological technique in the Caribbean and to bring up-to-date knowledge of the role of serology in syphilis control. The exchange of visits of outstanding men of science between the United States, Canada and Great Britain and the Caribbean area to exchange knowledge and stimulate research is a major objective of the Commission.

A West Indian Medical Conference at Trinidad was attended by representatives of all the medical departments of the British Colonies, while the necessary steps to set up the Caribbean Research Council and the four recommended research committees, dealing with public health and medicine, industries, building and engineering research and social science have now been taken at the sixth meeting of the Commission in Washington in March 1945, following on meetings of the Provisional Committees at St. Thomas in September 1944, when recommendations for membership and for the field of work of the Permanent Committees were made to the Council. The report also stresses the value of the West Indian Conference at Barbados in March 1944, and the Commission itself examined the question of the practicability of another such conference. While the conclusion was reluctantly reached that this was impracticable, it is hoped that a second West Indian Conference will be announced in due course; the Provisional Committee of the Caribbean Research Council has already recommended the establishment of a central secretariat to serve all committees and to work in liaison with the executive secretaries of the Commission. The Commission has also considered the creation of a permanent conference secretariat, but without regarding the matter as urgent pending the fixing of the date of the second conference.

* Anglo-American Caribbean Commission, 810 18th Street N.W., Washington, D.C.

ROYAL COLLEGE OF SURGEONS

SCIENTIFIC REPORT FOR 1944–45

THE Scientific Report of the Royal College of Surgeons for the year 1944–45 records welcome progress in reconstruction and reassembly of specimens dispersed during the War. Prof. R. A. Willis, the newly appointed Sir William H. Collins professor of human and comparative pathology, reports the return to the College of specimens which have been acquired since the disaster which the Museum suffered in 1941. There are more than six hundred of them, and they have been so well cared for during their dispersal that most of them have been added to the Museum. Prof. Willis and his staff have spent much time on problems of reconstruction, building, illumination and display of specimens. This report gives a list of the additions made to the Museum.

The Wellcome Trust has given £80,000 for the extension of the College's Museum, and it has been decided to name one wing of the new building the "Sir Henry Wellcome Wing". Up to July 1945 the College had received £122,000 of the £250,000 required to complete the restoration and development of the College.

The staff of the Department of Anatomy has been strengthened by the appointment of Prof. F. Wood Jones to the Sir William H. Collins chair of human and comparative anatomy. This department also has been occupied with problems arising from the war-time dispersal of its specimens to institutions and private residences, where they have been well looked after. No new anatomical preparations have been made this session, but the report records the other work of the department and gives a list of the additions made to the anatomical, osteological, physiological, odontological and historical sections of the Museum and also additions to the collections of instruments.

The Bernhard Baron Research Laboratories, under the direction of Prof. John Beattie, has, during the past five years, made important contributions to the study of blood transfusion, the maintenance of constant blood volume and problems of blood dilution when hæmorrhage occurs. Prof. Beattie here gives a valuable brief review of this problem. It was found that, in fully hydrated subjects, the plasma protein concentration did not fall as the hæmoglobin concentration fell, and that protein was being added to the extravascular fluid which was entering the circulation to restore the blood volume. This added protein came partly from the liver and partly from the muscles. The plasma protein moved out of the circulation as rapidly as it entered it after hæmorrhage, or sometimes even more rapidly. There is therefore in normal persons a protein store which can be rapidly mobilized into the blood stream. Prof. Beattie discusses the rate of this protein synthesis, which determines how much protein can be lost from the body (in exudates from wounds or burns, for example) without loss of weight or hypoproteinæmia. A study of this problem led to experiments, which are still in progress, on the intravenous administration of proteins, such as casein hydrolysates.

The problem of protein synthesis is also being attacked through the study of cases of infective hepatitis and allied diseases of the liver. People suffering from these diseases rapidly lose weight in the early phases, and the balance between intake and output of nitrogen is negative and accounts for practically all the loss of weight. A time comes, however, when the protein is again synthesized and retained; the nitrogen balance becomes positive and the excess of synthesis over destruction of protein can be measured. Much information about the rate of protein synthesis has been obtained by these studies. The relationships between necrosis of the liver and severe trauma and cessation of healing have also been studied.

The bearing of this work on the importance of diet in surgical care was shown by studies in Holland after the liberation, when the grossly inadequate protein intakes before liberation prevented or delayed healing of wounds, so that surgical work was practically at a standstill. Within a few weeks of increase of the protein ration and of the total caloric intake, surgical operations could again be undertaken. Supplementary feeding in the form of 100 gm. of protein daily given as predigested proteins rapidly speeded up wound healing and created a positive nitrogen balance. At the request of Supreme Headquarters, Netherlands, the Bernhard Baron Laboratories provided the nucleus of a laboratory team which went to Holland with the army of occupation to study the effects of long-continued deprivation of food in that country. A report on this work is being submitted to the Medical Research Council.

The laboratory has now returned to the Royal College of Surgeons. Dr. F. K. Sanders, Leverhulme Research Scholar at the Department of Zoology and Comparative Anatomy at Oxford, has continued his work on peripheral nerve injuries. G. LAPAGE.

A FRENCH MESOLITHIC SITE

THE rock-shelter of Cuzoul, near Gramat, is in the Lot (France). It is large in size, extending some 30 m. by 17 m. and 2½ m. high. The excavators* have unearthed seven archæological levels separated from each other by thin sterile layers. Industries, mainly mesolithic in date and culture, have been collected as well as associated fauna and some human remains from levels 2, 4 and 6. Level 2 yielded a complete skeleton.

As regards the industries, microlithic implements of Tardenoisean facies occur throughout. But in levels 6 and 7 they are associated with other, later, types such as leaf-shaped arrow-heads; and actually, in level 7, with tanged and tanged-and-winged arrow-heads and some pottery. The authors assign the industry of level 1 to the Sauveterrien, that of levels 2 and 3 to an early Tardenoisean, that of 4 and 5 to a later Tardenoisean, and that of levels 6 and 7 to a final stage of the same culture. This may well be correct, but one would venture to suggest that, in time, these industries of the upper two levels are of a latish neolithic or even an early metal age date. Such overlaps between the latest phases of the mesolithic and later cultures are well known in Britain, especially in Scotland. Again, the industries from Mugem (Portugal) and Axpea (Spain), though culturally speaking they appear to be mainly mesolithic, must be contemporary with much more recent cultures elsewhere. Except for the more recent additions in the upper two levels the industries as a whole are fairly similar. There are blunted backs, burins of various types, notched blades, awls, disks, scrapers, etc. But it is true to say that the lower levels show more affinities with an upper palæolithic industry than do the later ones. A bone perforated object and some large bone awls as well as a small pierced shell came from level 2, the complete skeleton layer.

In many ways one can say that the publication is a model. After describing the situation and the stratigraphy, an account of the fauna found is given. Then follows a detailed description of the finds, level by level, concluding with a brief comparative table. Following this comes an account of the human remains found, comparisons being made with those from Téviec and Mugem. In conclusion, there are eight full-page plates. The authors are to be congratulated on a really excellent piece of work, well performed and well published. M. C. BURKITT.

* Le gisement mésolithique du Cuzoul de Gramat. Par R. Lacam, A. Niederlender et H.-V. Vallois. (Archives de l'Institut de Paléontologie humaine, Mémoire 21.) Pp. iii+92+8 plates. (Paris: Masson et Cie., 1944.) 220 francs.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Sunday, May 5

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (at the Austrian Centre, 69 Greencroft Gardens, London, N.W.6), at 11.30 a.m.—Dr. L. Janossy: "Cosmic Rays".

Monday, May 6

SOCIETY OF CHEMICAL INDUSTRY (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.15 p.m.—Dr. E. Lester-Smith: "Penicillin".

Tuesday, May 7

CHADWICK PUBLIC LECTURE (at Caxton Hall, Westminster, London, S.W.1), at 2.30 p.m.—Major Eyre Carter: "The Rehabilitation of Stateless Persons and its Hygienic Bearings".*

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE (at Houghton Street, Aldwych, London, W.C.2), at 4.45 p.m.—Prof. Jacob Viner: "International Economic Relations" (to be repeated on May 14, 21, 28 and June 4).*

Wednesday, May 8

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. A. S. Parkes, F.R.S.: "Hormones".

INSTITUTE OF PETROLEUM (at 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. George Sheppard: "The Geology of the Guayaquil Estuary, Ecuador".

INSTITUTION OF ELECTRICAL ENGINEERS, TRANSMISSION SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. P. M. J. Ailleret: "The Evolution of the French Transmission Network".

BIRKBECK COLLEGE (at Breams Buildings, Fetter Lane, London, E.C.4), at 6 p.m.—Prof. C. A. Mace: "Democracy as a Problem in Social Psychology" (Inaugural Lecture).*

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—"The Scientific Life: its Motivation, Nature and Rewards" (Second Meeting). (Speakers: Sir Charles Darwin, F.R.S., Mr. E. C. S. Megaw, Prof. D. M. S. Watson, F.R.S., Prof. J. Z. Young, F.R.S., and Dr. S. Devons).

Thursday, May 9

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Annual General Meeting; (at Kingsway Hall, Kingsway, London, W.C.2), at 6.30 p.m.—Dr. T. E. Allibone: "Atoms, Electrons and Engineers" (Faraday Lecture).

Friday, May 10

ELECTRICAL ASSOCIATION FOR WOMEN (at the Connaught Rooms, Great Queen Street, London, W.C.2), at 10 a.m.—Twenty-first Annual Conference.

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. J. H. Oort: "Interstellar Matter" (George Darwin Lecture).

BEDSON CLUB (in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 5.30 p.m.—Sir Robert Pickard, F.R.S.: "Whither Chemistry?" (Sixty-third Bedson Lecture).

ROYAL STATISTICAL SOCIETY, LONDON GROUP OF THE INDUSTRIAL APPLICATIONS SECTION (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6.30 p.m.—Mr. P. J. Stanley: "The Accuracy of Automatic Lathes".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

CO-ORDINATOR OF RESEARCH AND PRINCIPAL OF THE PUNJAB AGRICULTURAL COLLEGE, Lyallpur—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2 (May 11).

LABORATORY TECHNICIAN FOR ZOOLOGY DEPARTMENT—The Secretary, University Science Laboratories, South Road, Durham (May 11).

LECTURER IN MECHANICAL ENGINEERING—The Principal, Handsworth Technical College, Golds Hill Road, Birmingham 21 (May 11).

LECTURER IN ELECTRICAL ENGINEERING—The Principal, Huddersfield Technical College, Huddersfield (May 11).

LECTURER (full-time) IN PHYSICS, an ASSISTANT LECTURER (full-time) in PHYSIOLOGY, a LECTURER (part-time) IN GEOLOGY, and a LECTURER (part-time) IN MATERIA MEDICA AND PHARMACY—The Principal, Technical College, Kingston-upon-Thames, Surrey (May 13).

STATE CHEMIST—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (May 14).

LECTURER IN CIVIL ENGINEERING—The Registrar, The University, Manchester 13 (May 18).

GAS EXAMINER AND OFFICIAL AGRICULTURAL ANALYST—The Town Clerk, Town Hall, Burnley (May 20).

TECHNICAL ASSISTANTS (male) for I.C. Engine Research Laboratory by British Oil Company Laboratory, near London—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting C.142.A (May 20).

LECTURER IN ELECTRICAL ENGINEERING—The Secretary, The University, Edmund Street, Birmingham 3 (May 30).

RESEARCH BIOLOGIST as a member of a team studying Plankton Ecology in relation to the Fisheries—The Registrar, University College, Hull (May 31).

ASSISTANT LECTURER IN CRYPTOGAMIC BOTANY—The Registrar, The University, Manchester 13 (June 1).

ENTOMOLOGISTS (2) to work on Tsetse Fly control measures, with special reference to the use of D.D.T. and other insecticides, in Southern and Northern Rhodesia—The Official Secretary to the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (Rhodesia, June 30).

LECTURER IN STATISTICS, and an ASSISTANT to the PROFESSOR OF POLITICAL ECONOMY—The Registrar, Trinity College, Dublin (July 1).

ASSISTANT PHYSICIST IN THE RADIOLOGICAL DEPARTMENT—The House Governor, Bristol General Hospital, Bristol 1.

BIOCHEMIST (man or woman) for work in the Pearson Cancer Research Laboratory—The House Governor and Secretary, Metropolitan Hospital, Kingsland Road, London, E.8.

ASSISTANT CHEMIST for research work involving analysis of soils and plant tissue—The Director, Experimental and Research Station, Cheshunt, Herts.

LECTURER IN ENGINEERING with special experience in Automobile Engineering, in Swindon College—The Borough Education Officer, Education Offices, Swindon.

LECTURERS (3) IN ELECTRICAL ENGINEERING—The Principal, Central Technical College, Suffolk Street, Birmingham 1.

LECTURER IN PHYSICS in the College of Technology—The Director of Education, Education Department, Leeds 1.

HEAD OF THE ENGINEERING DEPARTMENT of Walsall Technical College—The Director of Education, Education Offices, Darwall Street, Walsall.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Scientific Proceedings of the Royal Dublin Society. Vol. 24 (N.S.), No. 5: Developmental Lines in Pollination Mechanisms in the Coniferales. By Joseph Doyle. Pp. 43–62. (Dublin: Hodges, Figgis and Co. Ltd.; London: Williams and Norgate, Ltd., 1945.) 2s. [1810

National Institute of Economic and Social Research. Annual Report 1944–45. Pp. 22. Publications and Programmes. Pp. 22. (London: National Institute of Economic and Social Research, 1945.) [2210

Homage to Three Great Men: Schweitzer, Schrödinger, de Gennaro. By Dr. R. E. G. Armattoe. Pp. 12. (Londonderry: The Author, 7 Northland Road, 1945.) 1s. 6d. [2410

National Fruit Trials, 1921–1944. By J. M. S. Potter. Pp. iv+56. (London: Royal Horticultural Society, 1945.) 5s. [2410

The Place of the Scientist in Post-War Administration. By Prof. Harold J. Laski. Pp. 14. (London: British Association of Chemists, 1945.) [2410

The Rise and Fall of Japan. By Sir Frederick Whyte. Pp. 59. (London and New York: Royal Institute of International Affairs, 1945.) 1s. net. [2410

Edinburgh and East of Scotland College of Agriculture. Calendar for 1945–1946. Pp. 54. (Edinburgh: Edinburgh and East of Scotland College of Agriculture, 1945.) [2410

Fuel Luncheon Club. Pp. 24. (London: Fuel Luncheon Club, 1945.) [3110

Other Countries

Svenska Hydrografiska-Biologiska Kommissionens Skrifter. Ny Serie, Hydrografi 15: Östersjöns värmeekonomi. Av Nils G. Johnson. Pp. 18. 4 kr. Ny Serie, Hydrografi 16: Om tröghetssvängningar i Östersjön. Av Börje Kullenberg och Ilmo Hela. Pp. 14. 4 kr. Ny Serie, Hydrografi 17: Några iakttagelser från undervattenssprängningar vid Bornö Station, 1941 och 1942. Av M. Wretland. Pp. 4. 1 kr. Ny Serie, Hydrografi 18: Studier av isen i Gullmarfjorden. Av Nils G. Johnson. Pp. 22. 5 kr. Ny Serie, Hydrografi 19: A Standard Transparency-Meter. By Nils G. Johnson. Pp. 6. 2 kr. (Göteborg: Elanders Boktryckeri A.-B., 1940–1944.) [1810

Silvicultural Notes on some of the More Important Gold Coast Trees. Compiled by D. Kinloch. Pp. x+70. (Accra: Government Printing Department, 1945.) 2s. 6d. [1810

Development and Welfare in the West Indies. Bulletin No. 17: The National Income of British Guiana, 1942. Memorandum by Dr. Frederic Benham. Pp. 28. (Bridgetown: Advocate Co., Ltd., n.d.) 10 cents. [1810

League of Nations. Report on the Work of the League, 1943–1944. Submitted by the Acting Secretary-General. (Official No.: C.14.M.14, 1945.) Pp. 100. (Geneva: League of Nations; London: George Allen and Unwin, Ltd., 1945.) 2s. [1810

Niels Bohr. An Essay dedicated to him on the Occasion of his Sixtieth Birthday, October 7, 1945. By Prof. L. Rosenfeld. Pp. 18. (Amsterdam: N. V. Noord-Hollandsche Uitgeversmij., 1945.) 3s. [1810

Bericht über das Geobotanische Forschungsinstitut Rübel in Zürich für das Jahr 1944. Von E. Rübel und W. Lüdi. Pp. 140+4 plates. (Zürich: G. F. Rübel, 1945.) [1810

Academy of Sciences of the U.S.S.R.: Institute of Theoretical Astronomy. Ephemerides for the Determination of Time Corrections by Equal Altitudes (Zinger's Method) for 1945. Pp. 100. (Moscow and Leningrad: Academy of Sciences Press, 1945.) 10.50 roubles. [1810

Newfoundland Government: Department of Natural Resources. Research Bulletin No. 13: Salmon Investigations, 2: Atlantic Salmon of the East Coast of Newfoundland and Labrador, 1939. By A. A. Blair. Pp. 21. Research Bulletin No. 14: A Biological and Economic Study of Cod (*Gadus callarias*, L.) in the Newfoundland Area. By Dr. Harold Thompson. Pp. 160. Research Bulletin No. 15: The Life-History of the Spiny Dogfish (*Squalus acanthias*) and the Vitamin A Values of Dogfish Liver Oil. By Wilfred Templeman. Pp. 102. (St. John's: Department of Natural Resources, 1943–1944.) [1810